Canadian Natural

December 17, 2012

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Re: Canadian Natural Resources Limited – Kirby In-Situ Oil Sands Expansion Project
Oil Sands Conservation Act Application No. 1712215
EPEA Application No. 002-237382
Water Act File No. 00303825
Supplemental Information Request

Dear Mr. Schuldhaus, Ms. Kristensen and Mr. Banerjee,

Canadian Natural is pleased to provide you with the enclosed responses to the Supplemental Information Request provided by the Energy Resources Conservation Board (ERCB) on December 12th, 2012. Canadian Natural understands that a separate Supplemental Information Request from the Energy Resources Conservation Board (ERCB) will follow in due course.

Canadian Natural trusts the information is sufficient to continue the review of the Application for Approval and Environmental Impact Assessment.

Correspondence with respect to the enclosed information should be directed to:

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Sincerely,

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Enclosure

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GENERAL

PUBLIC ENGAGEMENT AND ABORIGINAL CONSULTATION

1. Volume 1, Section 10.7.3, Page 10-13. (Page 106 of SIR #1 – SIR 42)

It was indicated that TEK/TLU report from Chipewyan Prairie and Chard Métis Local #214 was expected late August 2012.

a. Provide an update on whether CNRL received the TEK/TLU report from Chipewyan Prairie and Chard Métis Local #214 and if so, how did CNRL use this information in their planning? If the information has not been received, provide an update on when the information is expected.

Response:

a. Canadian Natural Resources Limited (Canadian Natural) has not yet received Traditional Ecological Knowledge (TEK)/Traditional Land Use (TLU) information from Chipewyan Prairie Dené First Nation (CPDFN) or Chard Métis Local #214 (Chard). Canadian Natural understands that Chard and CPDFN signed an agreement in June 2012 to work together to complete a joint TLU/TEK report for the Kirby In Situ Oil Sands Expansion Project (the Project). Canadian Natural has provided capacity funding to support this undertaking. CPDFN has advised Canadian Natural that the final joint TEK/TLU report will be submitted by January 2013.

Upon receipt of the TEK/TLU report Canadian Natural will review the information provided and will work with CPDFN and Chard to identify and understand potential concerns and to develop suitable mitigation measures.

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2. Volume 1, General, Public Engagement and Consultation

CNRL provides a variety of responses on concerns and issues raised by First Nations and Aboriginal Groups through SIR Responses 42 to 53. It is challenging to track the issues and determine how they are being addressed by CNRL as many of the issued identified by the First Nations and Aboriginal Groups are overlapping. Some of the issues or concerns identified are specific and some are more general.

Some of the examples include Tables 42-1 and Table 42-2 which list the specific concerns raised from Heart Lake First Nation and Whitefish (Goodfish) Lake First Nation. However, in Tables 45-1 and 46-1, Chipewyan Prairie Dene First Nation and

Heart Lake First Nation's Concerns are listed in categories with a response by CNRL on how the concern is being addressed. Additional tables are also presented for other First Nations and in Table 51-1 Aboriginal Groups Issue Identification and Response is presented.

a. Provide a summary table that identifies and compiles all of the issues and how CNRL is responding and/or addressing the concerns raised. In this table include a column that identifies the First Nation (s) or Aboriginal Groups who raised the issue.

Response:

a. Canadian Natural received comments and concerns from Aboriginal groups through Technical Reviews, Statements of Concern and TEK/TLU reports and consultation activities (i.e., community open houses, meetings, emails and site flyovers). A summary of the concerns raised by Aboriginal groups during consultation activities and Canadian Natural's response to the concern is provided in Table 2-1. Many of the concerns raised during consultation activities were also raised in the Statements of Concern, TEK/TLU reports or Technical Reviews.

Canadian Natural has received Statements of Concern from Conklin Métis Local #193 (CML 193), CPDFN and Chard. Canadian Natural prepared responses to the Statements of Concern filed and provided responses directly to CML 193, CPDFN and Chard (November 13, 2012, November 20, 2012 and December 7, 2012 respectively) with a copy to Environment and Sustainable Resource Development (ESRD) and Energy Resources Conservation Board (ERCB).

To date Canadian Natural has received a draft TEK/TLU Report from Heart Lake First Nation and a final TEK/TLU Report from Whitefish Lake First Nation. Canadian Natural's response to the concerns raised by these Aboriginal groups is provided in the Traditional Land Use Update (Appendix 2-1).

CML 193 retained the services of Management and Solutions in Environmental Sciences (MSES) and Petroleum Geomechanics Inc. to undertake a third party review of the Application and EIA. Canadian Natural responded to each concern identified and provided this response to CML 193 on September 24, 2012. This information was also provided to ESRD and ERCB on November 13, 2012.

CPDFN and Chard also provided a third party technical review on August 27, 2012 which is currently undergoing community validation. Canadian Natural is currently working with CPDFN and Chard to identify an appropriate approach and schedule to discuss the issues identified in the technical review.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Athabasca Landing Métis Local 2012 (ALMA 2012)	Canadian Natural initially received a Statement of Interest regarding the Project however it has since been withdrawn.	
Beaver Lake Cree Nation (BLCN)	BLCN has not identified specific concerns, however on January 17, 2012, BLCN sent a letter to the governments of Alberta and Canada, identifying several general concerns they had regarding the Project.	Canadian Natural is continuing to make efforts to meet with BLCN to better understand their Project specific concerns.
Conklin Métis Local #193 (CML 193)	Concerned about funding capacity to complete a TLU/TEK study, Technical Review of Application and EIA and consultation.	Canadian Natural is providing capacity funding for CML 193 to engage in the consultation process, gather TLU information, and complete a technical review of the application and EIA.
	Expressed concerns regarding: Surface water, water use and ground water, wildlife, caprock integrity and biodiversity.	Responses to these concerns were provided in Canadian Natural's response to CML 193's Third Party Technical Review and Statement of Concern on September 24, 2012 and November 13, 2012 respectively. The responses were also provided to ESRD and ERCB on November 13th, 2012.
Chard Métis Local #214 (Chard)	No Project specific concerns were identified during the meetings with Chard	Canadian Natural responded to Chard's Statement of Concern on December 7, 2012
Chipewyan Prairie Dene First Nation (CPDFN)	The Project will be a direct infringement on current and traditional land use.	Canadian Natural provided capacity funding for CPDFN to gather TLU information for review and consideration by Canadian Natural. This information is expected in January 2013.
	Mitigation of land use impacts would be impossible without having the TLU work done first.	Traditional land use information has been collected from publicly available sources including other in situ applications submitted by fellow industry competitors, and through consultation, traditional land use reports, site visits and technical workshops in support of Kirby South 2010. Canadian Natural and CPDFN are continuing to work together to collect traditional land use information and a report is expected in January 2013. Upon receipt of the TEK/TLU report Canadian Natural will review the information provided and will work with CPDFN to identify and understand potential concerns and to develop suitable mitigation measures.
	The Project will be approved despite objections from the community.	Canadian Natural will continue to work with CPDFN to identify specific concerns and to develop appropriate mitigation measures to address the community's concerns.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Chipewyan Prairie Dene First Nation (CPDFN) (continued)	Concerned about the lack of jobs in the community even with developments.	Canadian Natural is committed to work with CPDFN community to explore areas within our four pillars – community investment, education and training, business development, and employment. In addition, Canadian Natural supports the continued development of local workforces near our operations. Canadian Natural's employment initiatives focus on increased participation of aboriginal peoples in employment with Canadian Natural and its contractors. Canadian Natural will continue to work with CPDFN to understand the community's interests and capacities in an effort to increase opportunities for local and Aboriginal businesses. Canadian will also continue to work with CPDFN to develop community-specific initiatives including employment and contracting opportunities.
	Access to traditional lands; access to hunting areas	Access to the Project Area for Aboriginal traditional land users is discussed in detail within the EIA (Volume 6, Section 2.5.4.2). This concern was also addressed in Canadian Natural's response to CPDFN's Statement of Concern.
	Concerned about the future, children, treaty rights, community has little to gain, would like to see some community development as a result of these projects.	Canadian Natural and CPDFN continue to work together to identify a range of measures to help CPDFN to benefit from the Project and other developments in the region. Canadian Natural is committed to work with CPDFN to explore areas within our four pillars – community investment, education and training, business development, and employment.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Chipewyan Prairie Dene First Nation (CPDFN) (continued)	Concerned about water contamination, casing failure, water rundown, drilling under water sources, potable water sources, Egg Lake and Christina River, and drilling causing drought conditions.	Canadian Natural will introduce design components throughout its operations to reduce or eliminate potential impacts on groundwater. Canadian Natural will follow detailed design parameters and procedures for drilling and completions to prevent casing failure. Both casing and cement will be designed to meet thermal operating requirements. The Kirby Expansion Project is located approximately 20 km southeast of Christina Lake and is on the southeast edge of the Christina Lake drainage basin but does not intersect the Christina River. Egg Lake is not located in the proposed Project Area. Canadian Natural will build and operate the Project in a manner that has no direct discharges to and minimizes impacts to surface water quality in local lakes and streams. The Kirby Expansion Project central processing facilities and well pads will be set back from lakes and streams by at least 100 m. Road and pipeline stream crossings will be constructed during frozen winter conditions to avoid sensitive time periods for aquatic resources and to minimize the introduction of sediments. Runoff water collected from the well pads and the central processing facilities will only be released to the environment if it meets regulatory limits for discharge. Water withdrawals for make-up water will draw from deep, groundwater aquifers. Water levels in surface water bodies and shallow aquifers will not be affected because of the depth of the aquifers and the presence of clay and shale layers, which restrict flow between the aquifers and the surface. Some of these concerns were also addressed in Canadian Natural's response to CPDFN's Statement of Concern.
	A general concern about a proposed disposal area [location not identified] and that its impact on air and water pollution may impact wild or country foods.	Water disposal wells will be completed in the McMurray Formation and will be drilled, completed, and tested to satisfy the requirements of ERCB Directive 051 (EUB 1994). Canadian Natural will work with CPDFN to understand which specific water disposal well area is of concern. A Human Health Risk Assessment (HHRA) was completed for the EIA (Volume 3, Section 4) and assessed the health risks associated with multiple routes of exposure, including those related to water, fish, wild game, plants, berries and soil. The HHRA concluded that the Project is not expected to adversely affect the quality of any of the foods traditionally consumed by the Aboriginal communities in the area. This concern was also addressed in Canadian Natural's response to CPDFN's Statement of Concern.
	Government guidelines are inadequate and cannot mitigate scientific uncertainty with respect to in situ projects.	Canadian Natural's mitigation measures are guided by government policy, standards, objectives and best management practices.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[a]	Canadian Natural Response
Chipewyan Prairie Dene First Nation (CPDFN) (continued)	Concerned about semi-truck traffic from the main access road.	Canadian Natural will co-operate with the RCMP, Alberta Transportation and other local traffic authorities to minimize Project traffic-related impacts. This issue was also addressed in Canadian Natural's response to CPDFN's Statement of Concern.
	Concerned whether the proposed 100 m setback from the open water of lakes was adequate in all cases, particularly where lakes in the area are ringed with muskeg and therefore the water edge is not necessarily the real edge of the lakes.	The 100-m setback is consistent with current oil sands practice and is the maximum value cited in the Government of Alberta Enhanced Approval Process (Government of Alberta 2012). An increased setback was established for Big Muskeg Lake (Unnamed Lake 1) based on consultation feedback.
	CPDFN expressed concern because from previous experience the TLU/TEK report has not been useful, not well understood and/or not even read.	Canadian Natural and CPDFN are continuing to work together to collect traditional land use information and a report is expected in January 2013. Upon receipt of the TEK/TLU report Canadian Natural will review the information provided and will work with CPDFN to identify and understand potential concerns and to develop suitable mitigation measures.
	CPDFN and Canadian Natural were not aligned on budget and scope of work to complete the consultation the process.	Canadian Natural has reached an agreement with CPDFN to provide funding for CPDFN to gather TLU information for review and consideration during the regulatory and environmental assessment process and undertake a technical review of the Project. CPDFN and Chard have also reached an agreement where the TLU Study and Technical review will identify and include the concerns of Chard. CPDFN has provided a technical review that is currently undergoing community validation. CPDFN has indicated that the TLU study is complete but will not be provided until after community validation in January 2013. Canadian Natural has received and responded to CPDFN's Statement of Concern.
Cold Lake First Nation	Chief Janvier and some councillors expressed concern that Canadian Natural does not acknowledge importance of Traditional Knowledge Assessments	Traditional Knowledge and TLU information was considered in the Wildlife Assessment, Terrestrial Vegetation Wetlands and Forestry Assessment, Aquatic Ecology Assessment, and Human Health Risk Assessment. The sections of the respective assessment describing the use of TEK and TLU information are as follows: • Wildlife Assessment (Volume 5, Sections 1.3 and 4.3); • Terrestrial Vegetation Wetlands and Forestry Assessment (Volume 5, Section 1.3 and 3.4); • Aquatic Ecology Assessment (Volume 4, Section 1.3 and 4.2); and • Air Quality Assessment (Volume 3, Section 2.3.5); • Human Health Risk Assessment (Volume 3 Sections 2.2 and 4.4). An analysis of the effects of the Project on traditional, medicinal and cultural purposes is found in the TLU Assessment Application Case as described in Section 2.5. Proposed mitigation strategies are identified in the TLU Assessment Mitigation section as described in Section 2.5.1.
	Emissions and Caribou Protection and Habitat	Canadian Natural is working to respond to these concerns.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[a]	Canadian Natural Response
Heart Lake First Nation (HLFN)	There was a concern about capacity or resources for the community to participate in the consultation process	Canadian Natural offered resources through an Initial Capacity Funding letter agreement and a Comprehensive Capacity Funding Agreement (CCFA). Canadian Natural and HLFN finalized a TLU Study Support Letter Agreement, which confirms the scope and budget to support the collection and submission of information for review during the regulatory process. On July 19, 2012, HLFN provided Canadian Natural with a draft copy of its *HLFN TLU/TEK Information as it relates to: Canadian Natural Resources Limited Re: Kirby In Situ Oil Sands Project* (HLFN 2012). Canadian Natural's response to the draft TEK/TLU report is provided in Appendix 2-1.
	Concerned that the community does not understand the potential effect associated with emissions	Canadian Natural has provided copies of the Application to HLFN and will work with HLFN to explain the scope of assessment, modelling and predictions that are found in the Application relating to Air Quality Assessment (Volume 3, Section 2) and the Human Health Risk Assessment (Volume 3, Section 4). Canadian Natural has offered to fund a review of the EIA for HLFN and a technical workshop as part of the CCFA. This concern was also addressed in Canadian Natural's response to HLFN's TEK/TLU Report (Appendix 2-1).
	Concerned about the impact air emissions with have on air quality, wildlife, medicinal plants and country foods	Canadian Natural will monitor Project emission sources in accordance with any conditions of the EPEA approval. Ground level predictions from Project emissions that could affect air quality and acid deposition are presented in the Air Quality Assessment. The Air Quality Assessment concluded that all Project related emissions will meet Alberta's Ambient Air Quality Objectives (Volume 3, Section 2). The predictions are used in the Human Health Risk Assessment (Volume 3, Section 4), Terrestrial Resources assessments (Volume 5) and Surface Water Quality Assessment (Volume 4, Section 3). As stated in Volume 3, Section 4.6.3, the Project is not expected to adversely affect the quality of any traditional foods. This concern was also addressed in Canadian Natural's response to HLFN's TEK/TLU Report (Appendix 2-1).

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Heart Lake First Nation (HLFN) (continued)	Ground Water, underground water reservoirs. Concerned that the oil and gas activity is drying out the earth.	Canadian Natural's water strategy is explained in the Hydrogeology Assessment (Volume 4, Section 5). Canadian Natural will draw water from groundwater aquifers. Make-up water used in the Project will come from deep, non-potable aquifers, the majority of which is considered saline. Water levels in surface waterbodies and shallow aquifers will not be affected because of the depth of the aquifers and the presence of clay and shale layers, which restrict flow between the aquifers and the surface. The disposal zone for wastewater is approximately 550 m below the ground surface and is separated from fresh water aquifers by thick layers of shale and oil-saturated sand, which will not allow vertical flow upwards into the fresh water aquifers. Canadian Natural will operate the disposal wells in such a way that causes minimal effect to the geological layers separating the disposal zone and the fresh water zones, which will prevent cross-contamination or migration of fluids. This concern was also addressed in Canadian Natural's response to HLFN's TEK/TLU Report (Appendix 2-1).
	Concerned that as Canadian Natural drains water from underground reservoirs, it will dry up muskeg.	Groundwater withdrawal for steam injection make-up water, utility water and domestic water is addressed in the Hydrogeology Assessment (Volume 4, Section 5). Water required for steam injection will primarily be withdrawn from saline aquifers at depths greater than 400 m below the ground. Water required for utility and domestic needs will be withdrawn from non-saline aquifers between 100 m and 200 m below the ground. To assess whether groundwater withdrawal (both saline and non-saline) has the potential to impact the volume of water in surface waterbodies (i.e., muskeg, lakes, creeks and streams), Canadian Natural constructed a forward-predicting model to determine how much surface water may infiltrate into shallow aquifers as the result of groundwater diversion for Project needs. This rate of infiltration was then compared to the volume of surface water measured in the Local Study Area (LSA) during low flow conditions (which occur during the winter season) because during low flow, aquatic life would be most sensitive to changes in water volume. The volume of infiltrating surface water due to groundwater withdrawal was predicted to have a negligible effect on the volume of surface water during low flow conditions and thus would have a negligible effect on aquatic life. In accordance with ESRD regulations, Canadian Natural will develop a Groundwater Monitoring Plan that will include monitoring water levels in shallow aquifers as well as monitoring the quantity and quality of near by surface waterbodies, including muskeg.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[a]	Canadian Natural Response
Heart Lake First Nation (HLFN) (continued)	The HLFN community does not see how their traditional land use trails and our wildlife crossings will coincide. The gaming trails are grown in. Trees have been planted around markers from the past. Animals have stopped using migration path and are now using existing crossings as paths.	Canadian Natural will provide wildlife crossing opportunities along above-ground pipelines, either over the pipe or under the pipe, approximately every 400 m. Specific locations will be based on caribou habitat suitability and the presence of game trails. Pre-construction wildlife surveys will be used in conjunction with available pipeline design drawings and traditional land use information to determine the most suitable crossing opportunities. This concern was also addressed in Canadian Natural's response to HLFN's TEK/TLU Report (Appendix 2-1).
	There was a concern that HLFN would not realize any economic benefits from the Project.	Canadian Natural and HLFN have had initial meetings to understand respective interests and economic opportunities arising from the Project. Canadian Natural will continue to work with HLFN to identify and develop appropriate economic opportunities for HLFN businesses and members.
	The area around Margie Siding has historical significance as many members lived there in the past.	As part of Project planning Canadian Natural has avoided the area around Margie Siding to minimize impacts from the Project however Canadian Natural will work with HLFN to understand any outstanding concerns.
	What impacts will arise from Canadian Natural's water strategy?	Canadian Natural's water strategy is explained in the Hydrogeology Assessment (Volume 4, Section 5). A principal goal of Canadian Natural's water strategy is to minimize impacts to surface water and potable groundwater. To achieve this Canadian Natural will recycle as much water as possible. Specific examples of components of the water strategy include: setting back well pads and the Central Processing Facilities at least 100 m from surface waterbodies; using recycled water, saline water and non-potable water for steam generation; and constructing wells to meet thermal operating requirements. Canadian Natural will also continually introduce design components throughout its operations to reduce or eliminate potential impacts on groundwater, including drilling and completion of groundwater observation wells. A groundwater management and response plan will be prepared in accordance with the terms specified in the EPEA Approval. The need for additional monitoring programs to address other Project operations, such as the operation of water source extraction wells and process wastewater injection wells, will also be addressed in the specific ERCB and EPEA approvals.
Metis Local 1949 Owl River (Owl River)	Two Grave Sites located on the Northeast of the Project Area	This information was presented to Canadian Natural on November 21, 2012. Canadian Natural will work with Owl River to ground truth these locations and to discuss mitigation measures if required.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Whitefish Lake First Nation (WLFN)	Concerned about impact that air emissions may have on wildlife, medicinal plants, and country foods	Ground level predictions from Project emissions that could affect air quality and acid deposition are presented in the Air Quality Assessment. The Air Quality Assessment concluded that all Project-related emissions will meet Alberta's Ambient Air Quality Objectives (Volume 3, Section 2). The predictions are used in the Human Health Risk Assessment (Volume 3, Section 4), Terrestrial Resources assessments (Volume 5), and Surface Water Quality Assessment (Volume 4, Section 3). Canadian Natural will monitor Project emission sources as specified in the EPEA Approval. A Human Health Risk Assessment (HHRA) was completed for the EIA (Volume 3, Section 4) and assessed the health risks associated with multiple routes of exposure, including those related to water, fish, wild game, plants, berries and soil. The HHRA concluded that the Project is not expected to adversely affect the quality of any of the foods traditionally consumed by the Aboriginal communities in the area. This concern was also addressed in Canadian Natural's response to WLFN's TEK/TLU Report (Appendix 2-1).
	WLFN wants to ensure that it is safe for community members to practice traditional activities in proximity to the facilities.	Subject to considerations of health and safety and construction constraints, Canadian Natural will work with WLFN to provide information and to develop strategies that will limit barriers or impediments for community members to continue to access the land and exercise their treaty rights. As Canadian Natural progresses through detailed design and prepares for construction, more information will be provided to WLFN as part of ongoing consultation efforts. This information will specify which areas will be excluded from traditional land use practices for safety and security reasons. As stated in Volume 3, Section 4.6.3, the Project is not expected to adversely affect the quality of any traditional foods and residents are encouraged to continue to consume these foods in the vicinity of the Project. A Human Health Risk Assessment (HHRA) was completed for the EIA (Volume 3, Section 4) and assessed the health risks associated with multiple routes of exposure, including those related to water, fish, wild game, plants, berries and soil. The HHRA concluded that the Project is not expected to adversely affect the quality of any of the foods traditionally consumed by the Aboriginal communities in the area. This concern was also addressed in Canadian Natural's response to WLFN's TEK/TLU Report (Appendix 2-1).

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[(a)]	Canadian Natural Response
Whitefish Lake First Nation (WLFN) (continued)	Indicated that several community members hold domestic fishing licenses in and around some of the lakes located within the proposed Project Area.	The WLFN provided a final traditional land use report on June 28, 2012 (Regional Municipality of Wood Buffalo and Lac La Biche County 2012), which includes a Resources and Activities map and details identifying specific areas where WLFN carry out hunting, trapping, fishing and gathering activities within the proposed Project Area. Canadian Natural and WLFN are working together to understand the potential impact and develop strategies to avoid or mitigate the potential effect. This concern was also addressed in Canadian Natural's response to WLFN's TEK/TLU Report (Appendix 2-1).
	Capacity funding is a concern for the community and WLFN requested support to participate in the consultation process and to complete a traditional land use study.	Canadian Natural and WLFN have completed an Initial Capacity Funding letter agreement, a Comprehensive Capacity Funding Agreement, and Traditional Land Use (TLU) Agreement. Each agreement provided resources to support WLFN through the consultation process and to gather and submit TLU information.
Saddle Lake Cree Nation (SLCN)	Capacity funding is a concern for the community and SLCN requested support to participate in the consultation process and to complete a traditional land use study.	Canadian Natural has offered resources through an Initial Capacity Funding letter agreement, a Comprehensive Capacity Funding Agreement and Traditional Land Use (TLU) Agreement. Each agreement would provide resources to support SLCN through the consultation process and to gather and submit TLU information. To date, SLCN has accepted some capacity funding, but will not commit to providing TLU information until a community agreement is reached. We continue to work with SLCN to resolve this matter.
	The SLCN has requested a defined consultation process.	Canadian Natural presented a consultation process as defined in the Comprehensive Capacity Funding Agreement (CCFA). The CCFA details consultation activities and resources related to the EIA review process, community meetings to share Project information, gathering traditional land use, participation in ongoing consultation meetings and a fly-over of the proposed Project Area. Saddle Lake Cree Nation has requested a process that is more comprehensive and would include activities related to ESRD applications, conventional, and heavy oil. SLCN has accepted some capacity funding, but will not commit to further engagement in the consultation process until a community agreement is reached. Canadian Natural continues to work with SLCN to resolve these concerns.
	The SLCN has requested a program to help educate its members in the oil and gas industry.	Canadian Natural indicated that a scholarship program is available for members. However, should there be specific areas of interest; SLCN was requested to submit these in writing for consideration.
	A major priority for the community is to get their companies involved in economic development related to the Project.	Canadian Natural's Business Development Coordinator is actively engaged with SLCN to understand community interests, capacity and opportunities for working together.
Fort McMurray First Nation (FMFN)	Capacity funding is a concern for the community and FMFN requested support to participate in the consultation process and to complete a traditional land use study.	Canadian Natural has offered resources through an Initial Capacity Funding letter agreement, a Comprehensive Capacity Funding Agreement and a Traditional Land Use (TLU) Agreement. Each agreement would provide resources to support FMFN through the consultation process and to gather and submit TLU information. To date, FMFN has not accepted any of the agreements.

Table 2-1 Concerns Identified During Aboriginal Consultation Activities (continued)

Aboriginal Group	Concerns[a]	Canadian Natural Response
Fort McMurray First Nation (FMFN) (continued)	Desire for long-term agreements with industry.	Canadian Natural is interested in understanding potential Project-related impacts on FMFN. Once concerns or concerns have been identified, Canadian Natural may consider discussions related to long-term agreements addressing mitigation measures and other benefits to FMFN commensurate with the level of Project impacts on FMFN.
	A major priority for the community is to get their companies involved in economic development related to the Project.	Canadian Natural's Business Development Coordinator is actively engaged with FMFN to understand community interests, capacity and opportunities for working together.
	FMFN is considering a different approach to the consultation process as they feel it doesn't seem to matter what information they provide (community concerns, TUS Reports) projects still get approved. FMFN wants to explore different models.	Canadian Natural indicated that we cannot avoid consultation for a number of reasons (legal, policy guidelines, community mandate…etc) but there are ways to develop consultation process that is effective for a range of different needs. Canadian Natural wants to understand the scope and magnitude of potential project related impacts to develop an effective mitigation plan. Canadian Natural proposed to develop a consultation process that would provide information for the community, allow experts (TUS or others) to view the proposed area through site visits or fly-overs, and to provide resources to gather and present traditional land use information as it relates to the Project Area. Concurrently, the parties could start to formulate a process by which we could identify common interests, economic opportunities and community priorities for investment. FMFN indicated interest in procuring a school bus for the community and would consider the discussion further and provide a response to Canadian Natural regarding next steps.
	The community is seeing depletion of the wildlife and sick moose. Hunters now have to travel hundreds of kilometres away to hunt for moose.	Canadian Natural assessed effects of Project on wildlife abundance, habitat and movement due to potential for habitat loss and alteration, direct and indirect mortality, and changes to human access and use in the EIA. Environmental consequences during construction and operation of the Project (Application Case) range from low to high at a local scale, and are negligible at a regional scale. In addition, a wildlife monitoring plan will be established to meet the requirements specified in the EPEA Approval. Canadian Natural will work with regulators to determine appropriate methods for mitigating or avoiding these effects, where possible. Reclamation of vegetation communities is predicted to result in the recovery of wildlife populations that experience decline due to Project construction and operations.

[a] The concerns in this column are captured from community open houses, meetings, emails, and during site flyovers. Many of the concerns raised during meetings, open houses etc. were also raised in the Statements of Concern, TEK/TLU Reports or Technical Reviews.

3. Volume 1, Section 10.7.3, Page 10-13. (page 111 of SIR #1)

a. Provide an update on whether CNRL has completed their response to Whitefish (Goodfish) Lake First Nation's concerns outlined in their TUS report? If a response has not been provided, provide an update on when a response will be provided by CNRL.

Response:

a. Canadian Natural responded to the concerns outlined in Whitefish (Goodfish) Lake First Nation's (WLFN) Traditional Use Study (TUS) report in the Traditional Land Use Update (Appendix 2-1). WLFN will be provided with a copy of the Traditional Land Use Update. Canadian Natural will continue to consult with WLFN on the Application and EIA.

4. Volume 1, Section 10.7.3, Page 10-13. (page 109-110 of SIR#1)

a. Confirm if Métis Nation of Alberta Region 1 has submitted their TEK/TUS report to CNRL in late August 2012 and if so, how has CNRL incorporated this into their planning for the project. If the report has not been submitted, provide an update on discussions held with Métis Nation of Alberta on when the report would be expected.

Response:

a. The Métis Nation of Alberta Region 1 has not submitted a TEK/TUS report to Canadian Natural. As noted Canadian Natural was expecting the final TEK/TUS report in August 2012. On September 28, 2012 Métis Nation of Alberta Region 1 advised Canadian Natural that a meeting was planned for early October 2012 to define roles and responsibilities regarding the TEK/TUS report. Métis Nation of Alberta Region 1 further advised Canadian Natural on October 5, 2012 that the consultant working on the TEK/TUS report (Willow Springs Strategic Solutions) was preparing for an ERCB hearing, which they deemed a priority over the completion of the TEK/TUS report.

At this time, Métis Nation of Alberta Region 1 has not provided a firm date for submission of a TEK/TUS report. Canadian Natural remains engaged with Métis Nation of Alberta Region 1 and committed to the completion of a TEK/TUS report. Canadian Natural is providing financial resources to support this work and is hopeful that a final TEK/TUS report will be completed and submitted in the near term.

Upon receipt of the TEK/TUS report Canadian Natural will review the information provided and will work with Métis Nation of Alberta Region 1 to identify and understand potential concerns and to develop suitable mitigation measures.

TRANSPORTATION

5. SIR 1, Appendix 57-1

Due to the expansion, the intersection likely needs to accommodate large trucks with large turning movements. The traffic Impact Assessment did not discuss design vehicle and whether the proposed Type II(c) intersection needs to be modified to accommodate such the design vehicle's turning movement. Illumination warrant should also be discussed as per Traffic Impact Assessment Guideline.

a. Provide design vehicle and confirm whether the intersection can accommodate its turning movements.

b. Confirm whether illumination is warranted.

Response:

a. The existing intersection of Highway 881 and the Project access road is built to a standard Alberta Transportation Type IIc configuration (a copy of the standard Type IIc layout can be found as Figure D-7e in Round 2 Supplemental Information Request [SIR] Appendix 5-1). Table D.5.2a of the Alberta *Highway Geometric Design Guide* (Alberta Transportation 1999) is shown in Appendix 5-1 and confirms that, for the right-turn movements from Highway 881 northbound or southbound, the three-centred curve corner treatment provided by the Type IIc intersection accommodates a WB-15 tractor-trailer, and as noted at the bottom of Table D.5.2a, can also accommodate a WB-21 tractor-trailer combination with no encroachment of wheels on the shoulders. It can also handle up to a WB-23 (Super B-train), with some encroachment of wheels onto the shoulders. Similarly, as shown in Table D.5.2b (Appendix 5-1), the Type IIc corner treatment provided for vehicles turning right out of the Kirby North site onto Highway 881 southbound or turning right out of the Kirby South site onto Highway 881 northbound can also handle up to a WB-21 design vehicle with no encroachment, and WB-23 with some tire encroachment onto the shoulders.

To date, the intersection has been able to accommodate turning movements of vehicles associated with Canadian Natural's Kirby South 2010 (KS1). Canadian Natural intends to use similar vehicles (including WB-15, WB-21 and WB-23) at the Kirby Expansion Project.

b. An illumination warrant assessment was conducted using the methods outlined in the Transportation Association of Canada's publication *Illumination of Isolated Rural Intersections* (TAC 2001). Key inputs to the illumination warrant assessment included physical aspects of the intersection (e.g., grades, sight distances, skew angle), two-way annual average daily traffic volumes on the major and minor roads, speed limits, and collision data.

Illumination warrants were assessed for two traffic scenarios, based on the information presented in the Transportation Impact Assessment report (Round 1 SIR, Appendix 57-1 [Canadian Natural 2012]). The specific scenarios reviewed were the "2015 Construction Horizon Combined Volumes" (Figure 2.7 of Appendix 57-1) and the "2035 Operations Horizon Combined Volumes" (Figure 2.8 of Appendix 57-1).

The warrant score for the 2015 and the 2035 traffic scenarios were 101 and 111 respectively. Both of these warrant scores are below the illumination warrant threshold of 120 points; therefore illumination is not warranted. Warrant calculation spreadsheets are attached in Appendix 5-1 for each scenario.

References:

Alberta Transportation. 1999. *Highway Geometric Design Guide*. http://www.transportation.alberta.ca/951.htm.

Canadian Natural (Canadian Natural Resources Limited). 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

TAC (Transportation Association of Canada). 2001. *Illumination of Isolated Rural Intersections*.

AIR

EMISSIONS MANAGEMENT

6. SIR 134 response a, Pages 166-167

Canadian Natural states *it has applied to license each CPF [central processing facility] as an individual facility, each having its own 0.99 t/d sulphur limit before requiring sulphur recovery, as per ERCB regulations (EUB 2001).* EUB Sulphur Recovery Guidelines 2001 and Interim Directive ID 2001-3 do not specifically refer to SAGD projects with multiple central processing facilities.

a. Explain how Canadian Natural would apply the EUB regulations to sulphur recovery at the Kirby Expansion project.

Response:

a. It is Canadian Natural's understanding that the ERCB will determine how the requirements for Interim Directive (ID) 2001-3 (EUB 2001) will be applied to the Application.

Based on the definition provided in ID 2001-3, "Sulphur inlet refers to the content expressed as tonnes sulphur equivalent contained in the feed stream to the processing plant", it is Canadian Natural's understanding that the sulphur recovery requirements are applied on a facility level. Furthermore, for Canadian Natural's Primrose and Wolf Lake (PAW) operations which includes a central processing facility (CPF) and three steam generation facilities, the ERCB applied ID 2001-3 individually to each of the four facilities. Accordingly it is Canadian Natural's understanding that the ERCB may take a similar approach when stipulating conditions for the Project as requested in the Application.

References:

EUB (Energy Utilities Board). 2001. *Interim Directive ID 2001-3. Sulphur Recovery Guidelines for the Province of Alberta.* August 2001. Calgary, AB.

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7. SIR 81 response a, Page 186

Canadian Natural states *the total fugitive total reduced sulphur (TRS) emissions were scaled from the Kirby South 2010 EIA based on the production capacity and that the total volatile organic compound (VOC) fugitive emissions were calculated by using the Devon Energy Corporation (Devon) Jackfish 3 Project (Devon 2010) as a basis*.

a. How was the Kirby South 2010 EIA total fugitive TRS emissions derived?

b. How was the total organic compound (VOC) fugitive emissions in the Devon Jackfish project derived?

Response:

a. The KS1 TRS emissions were based on the Suncor Firebag TRS emissions, which were derived from estimated fugitive losses from process areas and the expected sulphur content of the gas (Suncor 2003).

b. Clearstone Engineering was retained to calculate volatile organic compound (VOC) fugitive emissions for the Devon Jackfish 3 project. Clearstone derived VOC fugitive emissions based on flanges, valves, seals and drains associated with the Jackfish 3 project, and provided a speciation profile. The magnitude of emissions was based on measurements by Clearstone at other similar in situ facilities (Devon 2010).

References:

Devon (Devon NEC Corporation). 2010. *Application for Approval of the Devon Jackfish 3 Project*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Calgary, AB.

Suncor (Suncor Energy Inc.). 2003. *Suncor South Tailings Pond Project Application. Volumes 1 and 2.* Submitted to Alberta Energy and Utilities Board and Alberta Environment. December 2003. Prepared by Suncor Energy, Golder Associates Ltd. and Nichols Applied Management. Calgary, AB.

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8. SIR 81 response c, Pages 186 - 187

Canadian Natural states *Canadian Natural will verify the accuracy of these fugitive emission estimates using Leak Detection and Repair (LDAR) and an equipment maintenance program once the facility is operational.*

a. Describe such a program and explain how it will verify the accuracy of the fugitive emission estimates.

Response:

a. Canadian Natural's response to Round 1 SIR 81 (Canadian Natural 2012) should have stated that "Canadian Natural will verify the conservatism of these fugitive emission estimates using Leak Detection and Repair (LDAR) and an equipment maintenance program once the facility is operational."

The LDAR program will be designed to detect and then minimize and eliminate leaks in joints and flanges, and other potential sources as leaks are identified. With an effective LDAR program in place, leaks will be detected and repaired within 15 working days of detection unless a plant shut down is required (CCME 1993).

To verify the conservatism of these fugitive emission estimates, the number of leaking flanges, seals and valves will be totalled for each equipment type and the fugitive VOCs will be calculated using Canadian Association of Petroleum Producers stratified emissions factors (CAPP 2007). The total VOCs will vary on a year to year basis depending on the number of leaking equipment components. The calculated values will then be compared to the total VOCs used in the modelling assessment.

References:

Canadian Natural (Canadian Natural Resources Limited). 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

CAPP (Canadian Association of Petroleum Producers). 2007. *Management of Fugitive Emissions at Upstream Oil and Gas Facilities.* 2007-0003. Canadian Association of Petroleum Producers, Calgary, AB. Online: http://www.capp.ca/getdoc.aspx?DocId=116116&DT=PDF

CCME (Canadian Council of Ministers of the Environment). 1993. *Environmental Code of Practice for the Measurement and Control of Fugitive Emissions from Equipment Leaks.* Winnipeg, MB.

9. SIR 85 response d, Pages 192 - 194

On August 22, 2012, the Government of Alberta approved the Lower Athabasca Regional Plan and the associated Air Quality Management Framework (AQMF).

a. Compare predicted concentrations for the three development cases with the trigger levels in the AQMF.

Response:

a. The Air Quality Management Framework (AQMF) (AENV 2011) triggers are intended to be compared to ambient air quality monitoring data, and a management response is required if a trigger is exceeded. The AQMF triggers are not intended to be compared to predicted ground-level concentrations derived from dispersion modelling.

References:

AENV (Alberta Environment). 2011. *Alberta Ambient Air Quality Objectives and Guidelines Summary*. April 2011. Edmonton, AB.

DISPERSION MODELLING

10. SIR 99 response b, Table 99-2, Pages 211 to 213

Table 99-2 indicates that 24-h maximum sulphur dioxide concentrations occur on a rainy day.

a. Comment on the realism of such a situation.

Response:

a. The modelling was completed using the 5-year meteorological data set purchased from ESRD and results were analyzed according to ESRD approved methods, as described in response to Round 1 SIR 97 (Canadian Natural 2012).

Based on Canadian climate normals (1971-2000) for Cold Lake and Fort McMurray stations (Environment Canada 2011) for the month of May, rain occurred more than 30% of the time. Therefore, a rainy day in May is considered a realistic situation based on historical data.

References:

Canadian Natural (Canadian Natural Resources Limited). 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

Environment Canada. 2011. *National Climate Data and Information Archive – Canadian Climate Normals or Averages 1971-2000*. Available online at: www.climate.weatheroffice.gc.ca/climate_normals/index_e.html.

AIR QUALITY ASSESSMENT

11. SIR 108 response a, Pages 226 - 227

Canadian Natural states background is accounted for by the gridded areas sources.

a. Discuss whether the modeled concentrations agree with the measured background.

Response:

a. The modelled concentrations for background cannot be compared to measured background as there are no monitoring stations in the area that monitor only the background concentrations. Measured data contains contributions from the following sources:

- industrial facilities;
- non-industrial facilities; and
- background sources (e.g., traffic, homes, small equipment).

As per the modelling requirements (AENV 2009), modelling must include all three sources identified above. Emissions from the industrial and non-industrial sources are characterized and modelled as individual sources. Background sources (e.g., traffic, homes and small equipment) are estimated based on the data provided by Environment Canada (Niemi 2010, pers. comm.). There are no monitoring data available that would leave out the industrial and non-industrial facilities thereby leaving only the background data. Therefore, there is no means for comparison.

References:

AENV (Alberta Environment). 2009. *Air Quality Model Guideline*. Edmonton, Alberta. Viewed November 2011. (Online). http://environment.gov.ab.ca/info/library/7926.pdf

Niemi, D. 2010. Environment Canada, Pollution Data Branch, Hull Quebec. Email communication with Kim O'Neill at Matrix Solutions. September 2010.

WATER

HYDROLOGY

12. SIR 73, responses a and b, Pages 294-296

Canadian Natural indicated that very low flow in streams is often defined as the 7Q10 flow and that the very low flow condition is conservatively assumed to be derived solely from groundwater. Canadian Natural states that the amount of groundwater inflow is derived from the hydrogeological model and that actual flow statistics (i.e., 7Q10) are not used due to the lack of winter low flow time series data. As a result, the use of the groundwater-derived flow only is considered to be a conservative estimate of winter flow in streams.

a. Provide a description of the surface flow statistical condition (i.e., 7Q2, 7Q10, 7Q100) represented by the groundwater-derived inflow for the local study area.

Response:

a. Winter low flows are derived from shallow groundwater inflow and/or lake discharges rather than being dependent on overland flow and may change day-to-day due to ice formation. The groundwater-derived inflow in the response to Round 1 SIR 134b (Canadian Natural 2012) is derived from the hydrogeology model. The use of a hydrogeology model to estimate the change in the groundwater inflow is considered to be the most appropriate (and conservative) assessment of potential change in flow conditions in the Local Study Area (LSA) watercourses due to Project groundwater extraction.

As mentioned in the response to Round 1 SIR 134c, the Hydrological Simulation Program-Fortran (HSPF) model was validated based on Birch Creek open water data. Calibration of this model for winter conditions relied on the available oil sands region regional hydrometric stations for which winter flow data are available. These stations are primarily in larger watersheds. Winter flow data on smaller streams are known to be highly variable, and may not be well represented by the HSPF model. As a result, the simulated daily flows during winter are considered to have higher uncertainty compared to the simulated daily flows during open water season. While the HSPF-calculated average under-ice flow measurements compared favorably to the limited winter flow data that was obtained in the field (Round 1 SIR 134b), extreme winter low flows (such as the 7Q10) in small streams are particularly challenging to simulate.

The simulated statistical 7Q10 flow results (based on the HSPF model) for the winter low flow conditions are provided in Table 12-1. These values have greater flows than those derived solely from groundwater input (also provided in Table 12-1). As described above, the HSPF 7Q10 flows do not consider local groundwater recharge changes due to extraction. As a result, the 7Q10 flows increase for the Application Case and Planned Development Case (PDC) due to the change in surface cover runoff factors. This increase will exist even if the change in groundwater input is manually subtracted from the HSPF model-derived results. As a result, Canadian Natural considers the groundwater-derived flow methodology used in the impact assessment to be a conservative assessment of the potential impact on low flows due to groundwater extraction in the LSA. The results are discussed in comparison to the 7Q10 flow statistic, rather than the 7Q2 or 7Q100, because this is a commonly used reference point for assessment of low flows in the oil sands region.

It is not possible to do statistical flow analysis for the groundwater flow input since there is no dataset or measurement methodology on which to base this analysis. Therefore, the groundwater-derived inflow cannot be reliably related to a surface flow statistical condition.

Table 12-1 Low Flows Comparison Between Hydrological and Hydrogeological Modelling Results

Assessment Node	Drainage Area [ha]	Project Stage	Flow Statistics	Hydrological Modelling Results					Hydrogeological Modelling Results[a]				
				Case			% Change from Baseline Case		Case			% Change from Baseline Case	
				Baseline Case	Application Case	PDC	Application Case	PDC	Baseline Case	Application Case	PDC	Application Case	PDC
Birch Creek Sub-basin													
BC-N1	155	HSPF Model	7Q10 [L/s]	41.2	42.5	42.5	3.2	3.2					
	155	Groundwater Derived Only	[L/s]						16.7	16	15.3	-4.1	-8.2
BC-N2	237	HSPF Model	7Q10 [L/s]	63.2	64.0	64.0	1.4	1.3					
	237	Groundwater Derived Only	[L/s]						70	68.8	67.6	-1.6	-3.4
BC-N3	262	HSPF Model	7Q10 [L/s]	69.8	69.7	69.6	-0.1	-0.3					
	262	Groundwater Derived Only	[L/s]						70	68.8	67.6	-1.6	-3.4
Sunday Creek Sub-basin													
SC-N1	77	HSPF Model	7Q10 [L/s]	27.9	29.1	29.3	4.1	4.8					
	77	Groundwater Derived Only	[L/s]						0	0	0	0	0
SC-N2	130	HSPF Model	7Q10 [L/s]	56.9	58.0	58.0	1.9	1.9					
	130	Groundwater Derived Only	[L/s]						6.4	6.3	6.2	-1.7	-4
SC-N3	383	HSPF Model	7Q10 [L/s]	147	148	149	1.0	1.4					
	383	Groundwater Derived Only	[L/s]						45	44.3	42.9	-1.6	-4.8
Winefred Lake Tributary Sub-basin													
UNT-N1	109	HSPF Model	7Q10 [L/s]	45.7	45.7	45.7	0.01	0.01					
	109	Groundwater Derived Only	[L/s]	expected to return to near pre-development flows					25	24.9	24.8	-0.4	-1
UNT-N2	250	HSPF Model	7Q10 [L/s]	93.5	93.7	93.7	0.23	0.23					
	250	Groundwater Derived Only	[L/s]						25	24.9	24.8	-0.4	-1
Wiau River Sub-basin													
WLT-N1	184	HSPF Model	7Q10 [L/s]	71.1	74.1	74.1	4.1	4.1					
	184	Groundwater Derived Only	[L/s]						n/a	n/a	n/a	n/a	n/a
WL-N1	281	HSPF Model	7Q10 [L/s]	75.2	76.5	76.6	1.8	1.8					
	281	Groundwater Derived Only	[L/s]						37.6	37.4	37.1	-0.6	-1.3
WR-N1	317	HSPF Model	7Q10 [L/s]	75.2	76.5	76.6	1.8	1.8					
	317	Groundwater Derived Only	[L/s]						37.6	37.4	37.1	-0.6	-1.3

[a] Low flows values for Baseline Case using the minimum baseflow estimated for the watercourses; low flows values for Application Case and PDC using the maximum baseflow reduction (conservative estimate).

Reference:

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

AQUATICS

13. SIR 138 responses a and b, Pages 299-303

Discussion of poly-aromatic hydrocarbon (PAH) degradation rates in water only was provided, but no degradation rates or total accumulation of PAHs in snowpacks (e.g., Kelly et al. 2009) that might suddenly be released during snowmelt and concentrated in sediments was included.

a. Quantify the potential for PAHs to accumulate over the winter in snowpack and then be released to water and/or bound to sediments during spring melt.

b. Describe whether spring pulse-released PAHs may impact aquatic biota residing in water and sediments in local streams and lakes.

Response:

a. The results of Kelly et al. (2009) are not directly applicable to the Project. Kelly et al. collected poly-aromatic hydrocarbon (PAH) samples over 100 km to the north of the Project. Oil sands developments in Kelly et al.'s sampling area are primarily surface mining operations which emit relatively greater amounts of particulate matter in the form of fugitive dust than in situ operations. Particulate matter in the form of fugitive dust represents the most likely source of PAHs measured in snow. Surface mining operations employ a vehicle fleet of large mining equipment that also contributes to PAH emissions via exhaust. The Project uses in situ bitumen extraction (Steam Assisted Gravity Drainage [SAGD]) that results in substantially lower emissions of particulates, because it does not require a vehicle fleet of large mining equipment.

Although deposition predictions are not available for a quantitative prediction of the contribution of PAHs to surface waters from snowmelt during Project operation, available information indicates that this pathway will contribute negligible amounts of PAHs to surface waters:

- The Project will be burning natural gas as a fuel source and will not include the combustion of coke or refinery fuel gas that occurs in oil sands mining and upgrading operations. Natural gas combustion releases relatively small amounts of particulate matter (Lee et al. 2004; Rogge et al. 1993).

- As shown in Table 2.7-9 of the Air Quality Assessment (Volume 3, Section 2.7.7 of the December 2011 Application [Canadian Natural 2011]), maximum predicted concentrations of benzo(a)pyrene in the LSA are well below the Alberta Ambient Air Quality Objectives (AAAQO). ESRD develops AAAQOs based on scientific, social, technical and economic factors that include substance behaviour in the environment, such as bioaccumulation and biodegradation after entering the environment.
- Teck (2011) evaluated the effect of PAH deposition on snowmelt quality using a conservative quantitative method and predicted that the effect of PAH emissions from the Frontier project on snowmelt quality will be negligible. The Frontier project is an oil sands surface mine, which is predicted to have a substantially greater rate of PAH emissions than the Project (4.24 kg/d from Frontier vs. 0.031 kg/d from the Project). Despite higher PAH emissions, Teck (2011) predicted a mean increase in PAH concentration of 0.05 ng/L in snowmelt due to project activities in the Frontier LSA, which is well below the analytical detection limit of 10 to 50 ng/L for PAHs (Teck 2011, Table 4-27).
- The response to Round 1 SIR 138 (Canadian Natural 2012) outlines the rapid degradation rate of PAHs in water, indicating that even the negligible amounts of PAHs introduced from snow melt would rapidly degrade in surface waters.

b. As stated in the response to part a and the response to Round 1 SIR 138, the rapid degradation rate of PAHs in water indicate that even negligible amounts of PAHs introduced from snowmelt would rapidly degrade in surface waters. Therefore, the potential impact to aquatic biota from the sudden release of PAHs during the spring pulse is expected to be negligible.

References:

Canadian Natural (Canadian Natural Resources Ltd). 2011. *Kirby In Situ Oil Sands Expansion Project: Application for Approval*. Submitted to Alberta Environment and Alberta Environment and Water. December 2011.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information.* Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Kelly, E.N., J.W. Short, D.W. Schindler, P.W. Hodson, M. Ma, A.K. Kwan and B.L. Fortin. 2009. *Oil sands development contributes polycyclic aromatic compounds to the Athabasca River and its tributaries*. PNAS 106 (52): 22346-22351.

Lee, J.H., C.L. Gigliotti, J.H. Offenberg, S.J. Eisenreich and B.J. Turpin. 2004. *Sources of polycyclic aromatic hydrocarbons to the Hudson River Airshed*. Atmo. Environ. 38 (35): 5971-5981.

Rogge, W.F., L.M. Hildemann, M.A. Mazurek, G.R. Cass and B.R.T. Simoneit. 1993. *Sources of fine organic aerosol. 5. Natural gas home appliances*. Env. Sci. Tech. 27: 2736-2744.

Teck (Teck Resources Limited). 2011. *Frontier Oil Sands Mine: Integrated Application*. Submitted to Alberta Environment and Sustainable Resource Development. November 2011.

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14. SIR 138 responses a and b, Pages 299-303

Additional information was provided about industrial emissions that might be expected for metals and poly-aromatic hydrocarbons. More information about aluminum (Al) emissions was specifically requested because of the high baseline concentrations of Al. The response, including the modelled values provided in Tables 138-1, did not mention Al.

a. **Provide predicted Al values within Tables 138-1 and identify any potential aquatic toxicity concerns with high levels of Al during the spring acid pulse period.**

Response:

a. The United States Environmental Protection Agency (U.S. EPA) AP-42 (U.S. EPA 1995) was the source of metals emission factors for applicable combustion sources from the Project. The U.S. EPA does not provide an emission factor from these combustion sources for aluminum. In addition, an AAAQO is not available for aluminum. As a result, aluminum emission rates were not estimated or modelled for the Project, so predicted aluminum concentrations cannot be provided. Furthermore, the *Guide to Preparing Environmental Impact Assessment Reports in Alberta* (Government of Alberta 2011) specifies that only heavy metals are to be assessed as part of the Air Quality Assessment, which does not include aluminum.

However, the Surface Water Quality Assessment included an Air Emissions Effects assessment which predicted that equilibrium snowmelt pH in the Application case would be the same as in the Baseline Case (Volume 4, Section 3.6.3.2 of the December 2011 Application [Canadian Natural 2011]). This is due to an acid buffering effect of aluminum dissolution at low pH. No additional aluminum was predicted to solubilise as a result of the Project. The Application Case dissolution rates were predicted to be nearly the same as the Baseline Case. The amount of dissolved aluminum produced during the spring melt was at or below the detection limit for aluminum (0.001 µg/L) and hence is not expected to contribute to the total aluminum loading to waterbodies in the Air Quality Regional Study Area (RSA). Therefore aquatic toxicity effects due to potential aluminum deposition into waterbodies are also not expected.

Furthermore, the input of aluminum to waterbodies through deposition on waterbody surfaces and catchment areas is expected to be negligible compared to aluminum input via erosion and potential internal sources (e.g., bottom sediments). As an example, aluminum transport to Edwards Lake (4 km from the Project) during the spring melt under current conditions was estimated by measuring the change in total aluminum concentration between winter (March 13, 2008) and spring (May 15, 2008). The change in aluminum concentration was 0.02 mg/L, or an estimated 19 kg increase in aluminum in the entire lake volume (Table 14-1). The increase in aluminum concentration implies a 0.14 kg/ha input of aluminum to the lake. For comparison, an estimated 30,000 kg/ha of aluminum exists in the top 5 cm of lake bottom sediments, representing a large potential internal source. This calculation is based on a measured 2% clay proportion of sediment in Edwards Lake, and an assumed equal mixture of kaolinite and gibbsite in the clay fraction. The input of aluminum from sediment resuspension represents a potentially greater source of aluminum to the lake than inflow from the catchment during the spring acid pulse period. This example emphasizes that aluminum input from the Project would be negligible compared to internal aluminum sources.

Table 14-1 Baseline Aluminum Concentrations in Edwards Lake

Parameter	Total Aluminum	Waterbody Catchment Area [ha]	Waterbody Surface Area [ha]	Waterbody Volume[a] [L]	Sediment Concentration[b] [g/kg]	Sediment Densities[c] [kg/m³]
Lake concentration in winter	0.02 mg/L	67	67	930,000,000	1,230	2,300 (gibbsite) 2,600 (kaolinite)
Lake concentration in spring	0.04 mg/L					
Change in lake concentration during snowmelt	0.02 mg/L					
Change in mass in lake during snowmelt	19 kg					
Estimated input to lake during snowmelt under present conditions	0.14 kg/ha					
Potential aluminum input from sediment resuspension	30,000 kg/ha					

(a) Estimated from satellite imagery and a maximum depth of 1.5 m.

(b) Aluminum concentration and percent clay measured in the fall of 2007.

(c) Mineral density from Engineering Toolbox (2012).

References:

Canadian Natural (Canadian Natural Resources Ltd). 2011. *Kirby In Situ Oil Sands Expansion Project: Application for Approval*. Submitted to Alberta Environment and Alberta Environment and Water. December 2011.

Engineering Toolbox. 2012. *Densities of Common Minerals.* Accesses from http://www.engineeringtoolbox.com/mineral-density-d_1555.html. Accessed on December 2011.

Government of Alberta. 2011. *Guide to Preparing Environmental Impact Assessment Reports in Alberta*. Environmental Assessment Program. February 9, 2011

U.S. EPA. (United States Environmental Protection Agency). 1995. *Compilation of Air Pollutant Emission Factors. Volume 1: Stationary Point and Area Sources. Document AP-42*. U.S. EPA, Office of Air Quality Planning and Standards. 27711. Research Triangle Park, NC

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15. SIR 142, Page 322, and SIR 146, Figure 146-1a, Pages 328 and 332

Canadian Natural indicated their 100 m buffer zone/setback would be measured from the *mapped edge of open water*. The mapped edge of watercourses appears in Figure 146-1a as 100 m on either side of a blue line.

a. Does Canadian Natural plan for field-based measurements of 100 m setbacks from the top of bank or high water marks for final design placement of their project infrastructure? If not, how would Canadian Natural ground-truth their planned 100 m setbacks from surface waters?

Response:

a. Canadian Natural's field-based measurements of the planned 100 m Project infrastructure and facility setbacks will be from the high water marks of watercourses and waterbodies. For consistency in field based measurements, the ordinary high water mark as defined by Fisheries and Oceans Canada (DFO 2010) will be used.

In most cases within the Project Area, the mapped edge of open water is consistent with the ordinary high water mark.

Reference:

DFO (Fisheries and Oceans Canada). 2010. *Pacific Region Habitat Definitions*. January 13, 2010. Accessed December 3, 2012 at: http://www.pac.dfo-mpo.gc.ca/habitat/glossary-glossaire-eng.htm

TERRESTRIAL

TERRAIN AND SOILS

16. SIR 181 responses a, b, and c, Pages 397 to 401
Terrain and Soils Baseline Report, Section 3, Pages 21 and 23
Terrain and Soils Baseline Report, Table 15, Page 54
Terrain and Soils Baseline Report, Attachment B
Terrain and Soils Baseline Report, Attachment C, Section 3.4, Page C-18
Soil Maps provided by Canadian Natural upon Request

In response to SIR 181, Canadian Natural claims the use of Geographic Information System (GIS)/Light Detection and Ranging (LiDAR)/Digital Terrain Models (DTM)/ Object-Based Image Analysis (OBIA) technology results in better soil mapping precision and less need for ground-truthing than the use of traditional mapping methods.

Canadian Natural provided a map with the soil polygons over-laid on the LiDAR slope-shade base, showing a match of line placement to surface form. The linework is similar to what an experienced air photo interpreter ("traditional soil surveyor") would produce.

Approximately 150 soil inspection locations and the corresponding soil map units were checked against the Soil Inspection Listing (Attachment B of the Terrain and Soils Baseline Report) and Soil Map Unit Composition Matrix for the local study area (LSA) (Table 15, Terrain and Soils Baseline Report). The following concerns were identified:

a. **Some soil delineations include very unlike landscape types that could/should be separated.**

b. **Comparing ground-truthing to soil delineation labels found the following:**

c. **Several soil delineations had inspection site data that did not match the soil label:**

   i. **A delineation labelled WNF2 had one soil inspection (PBS006), which was a Mildred soil.**
   ii. **Soil delineation KEL2 is a large polygon containing ms118 (KNS), ms133 (KELxc), ms134(KNS) and ms135 (KNS). Kinosis is not listed as part of the soil map unit composition, yet it seems to be prominent in the delineation.**
   iii. **Delineation WNF5 contains inspection sites cm095 (MRN), cm096 (FRTzb) and cm097 (HRR). None of the soil series are listed as components of WNF5.**

d. **There were numerous instances of the soil series inspection data not being a component of the soil map unit composition:**

   i. **ELSpt (PBS122) is on the boundary between MIL2 and BMT2-0, but is not in either soil map unit complex.**
   ii. **HLY (RDS-002) is not listed in the KNS6 composition.**
   iii. **GGG (RPM013) is not listed in the MUS2m composition.**
   iv. **GGG (ms074) is not listed in the MLD2m composition.**
   v. **KEL (ms081) is not listed in the MLD2m composition.**
   vi. **KEL (ms101) is on the boundary between KNS5 and KNS6, but is not in either soil map unit complex.**
   vii. **KEL (ms 103) is not listed in the KNS6 composition.**
   viii. **HRR (ms109) is not listed in the KNS6 composition.**
   ix. **KNS (ms118) is not listed in the KEL2 composition.**
   x. **FRT (JBM066) is not listed in the KNS6 composition.**
   xi. **HRR (JBM081) is not listed in the MLD2m composition.**
   xii. **HRR (JBM087) is on the boundary between KNS6and MUS1m-U, but is not in either soil map unit complex.**
   xiii. **GYP (JBM096) is on the boundary between MLD3 and KEL2, but is not in either soil map unit complex.**

e. **The LSA has a complex mix of sand veneers over till, till and lacustrine/fluvial sediments:**

   i. **There are Luvisols and Brunisols on sand veneers over till.**
   ii. **The Brunisols on sands are a mixture of Dystric Brunisols and Eutric Brunisols. These cannot be predicted/separated using GIS models, but they are important for predicting potential acid input (PAI) impacts.**
   iii. **Mapping discipline and map unit concepts:**
   iv. **There is a lack of discipline in the delineation of soil landscapes:**

f. There are many very small, simple delineations and there are many very large complex delineations of unlike soils.

g. The soil map unit legend is very complex, with Dominant Series (60-70%), Significant 1 (10-20%), Significant 2 (5-10%), and Inclusions 1,2,3 (5% each) - this is a very theoretical/unusual/forced structure. There is no room for a range of dominance [e.g., Dominant (80-90%) plus inclusions], that is usually found in natural landscapes.

h. The level of ground-truthing (12% of delineations) does not support the very complicated soil legend.

Canadian Natural states ground-truthing was limited by poor access: The area north of the railway (Township 13-75-9W4) has no ground-truthing and the soil map is very dynamic, but there are wellsites, roads and trails in the area.

The quality assurance and control measures were described by Canadian Natural in Section 2.4 of Attachment C (Terrain and Soils Baseline Report [Canadian Natural 2011]). Canadian Natural states This was an iterative process with the geomorphic surface polygon base, and often resulted in additional polygon delineations, corrections of unrealistic soil map units that were previously applied to the data set, and development of new map units upon investigation of field soil survey data. The statement indicates the mapping system used is not predictive and often the soil survey data did not match the GIS map. Ground-truthing is still required to validate the soil maps.

Based on the review of information provided by Canadian Natural, the soil mapping results from the GIS-based system has not been shown to be better, more reliable or more precise than mapping by traditional methods. There is therefore no apparent justification for greatly reduced ground-truthing than what is required in the Guide for Preparing Environmental Impact Assessment Reports in Alberta (Appendix B of Alberta Environment, 2011).

i. Provide a level of ground-truthing that covers at least the Project Areas as defined in the Guide to Preparing an EIA, and demonstrates that the soils maps are reliable.

Response:

Based on ESRD's feedback Canadian Natural is preparing a revised map which includes:

- The results of a soil survey that was undertaken between October 22 and November 2, 2012. This survey focused on ground-truthing of the revised polygons on the Project footprint to meet an inspection distribution of 90% of map unit delineations that intersect the Project Area.

- Simplification of organic map units names (and numbers) as recommended by ESRD.
- Setting a minimum polygon size of 2 ha in the soil map, as per the Agriculture Canada (1981) standard for a 1:20,000 scale map.
- Additional scrutiny of the field soil inspection classifications, and revisions of soil inspection names, where applicable, that have parent material types that were re-assessed differently post-field.
- Manual revisions to polygon boundaries to correct discrepancies between the upland inspections occurring within simple organic map units, and organic inspections occurring within simple upland map units.
- Map unit-level assessment of areal extents for soil types, rather than assigning a “theoretical” map unit composition that adds to 100% and estimates areal extents of minor/inclusion soils.

The preliminary revised map includes 319 polygons in the LSA that intersect the Project Area, 287 of which contain at least one inspection (including the inspections from the additional field work completed in October/November 2012). This means that 90% of polygons that intersect the Project Area have at least one inspection. There are 416 inspections in the 1,570 ha Project Area. This corresponds to an inspection density of 1 inspection per 3.8 ha (SIL1 inspection density). This corresponds to an SIL index of 0.04, which is within the very detailed end of the range for an SIL2 according to Valentine and Lidstone (1985). The resulting map, results and supporting documentation will be provided to ESRD in February 2013.

These values could change slightly as the map is finalized; however, it will not change the conclusion that the SIL2 survey density has been achieved for the Project Area and LSA, and will not change the fact that 90% of the polygons intersecting the Project Area have at least 1 inspection in them.

Canadian Natural has also reviewed the comments provided in the preamble and still considers the approach for soil mapping was appropriate for Project-level planning and assessment of potential effects, accordingly the conclusions of the Soil and Terrains Assessment are not predicted to change.

References:

Agriculture Canada. 1981. *A Soil Mapping System for Canada (Revised)*. Land Resource Research Institute. LRRI Contribution Number 142.

Valentine, K.W.G. and A. Lidstone. 1985. *Specifications for Soil Survey Intensity (Survey Order) in Canada*. Can. J. Soil Sci. 65: 543-553.

17. SIR 185, Responses a and b, Pages 407-408

Canadian Natural states *the timeline to certification will be based on the effectiveness of re-vegetation and the establishment of a sustaining landscape that requires minimal ongoing maintenance, and that it is not possible to predict the time for certification and return to the Crown at this time.*

Canadian Natural's response does not fulfill the terms of reference which state that anticipated timeframes for completion of reclamation stages and release of lands back to the Crown, including an outline of the key milestone dates for reclamation and how progress to achieve these target will be measured.

While there are many variables and uncertainties with reclamation, a rough timeline (in decades, if necessary) should be provided to gauge the timeframe of reclamation stages.

a. Based on current knowledge of reclamation practices and results in the oils sands region, provide an estimated timeframe for the establishment of prescribed end land uses.

Response:

a. A conceptual schedule for well pad construction, operation, decommissioning and reclamation is detailed in Table 17-1. This schedule was considered to best reflect the various stages of development and reclamation for the Project. Infrastructure, access roads, pipelines and power lines associated with each well pad will be constructed, decommissioned and reclaimed on similar timelines as the well pads. The CPF will be constructed concurrently with the first well pads, and then decommissioned and reclaimed at the same time as the last well pad.

Table 17-1 Conceptual Schedule for Construction, Operation, Decommissioning and Reclamation of Kirby Expansion Project Well Pads

Year	# of Well Pads in Construction	# of Well Pads in Operation	# of Well Pads to be Decommissioned	# of Well Pads Starting Reclamation	Cumulative # of Well Pads Completed Reclamation	# of Well Pads Achieving Proposed End Land Use and Potentially Ready for Certification	Cumulative # of Well Pads Certified
2014	3	0	0	0	0	0	0
2015	2	0	0	0	0	0	0
2016	2	3	0	0	0	0	0
2017	2	5	0	0	0	0	0
2018	6	7	0	0	0	0	0
2019	4	9	0	0	0	0	0
2020	7	15	0	0	0	0	0
2021	4	19	0	0	0	0	0
2022	5	26	0	0	0	0	0
2023	5	30	0	0	0	0	0
2024	5	35	0	0	0	0	0
2025	4	40	0	0	0	0	0
2026	7	42	3	0	0	0	0
2027	3	44	2	3	0	0	0
2028	5	49	2	2	0	0	0
2029	3	50	2	2	3	0	0
2030	5	49	6	2	5	0	0
2031	0	48	4	6	7	0	0
2032	0	46	7	4	9	0	0
2033	0	42	4	7	15	0	0
2034	0	37	5	4	19	0	0
2035	0	32	5	5	26	0	0
2036	0	27	5	5	30	0	0
2037	0	23	4	5	35	0	0
2038	0	16	7	4	40	3	0
2039	0	13	3	7	45	2	5
2040	0	8	5	3	49	2	7
2041	0	5	3	5	56	2	9
2042	0	0	5	3	59	6	15
2043	0	0	0	5	64	4	19
2044	0	0	0	0	67	7	26

Table 17-1 Conceptual Schedule for Construction, Operation, Decommissioning and Reclamation of Kirby Expansion Project Well Pads (continued)

Year	# of Well Pads in Construction	# of Well Pads in Operation	# of Well Pads to be Decommissioned	# of Well Pads Starting Reclamation	Cumulative # of Well Pads Completed Reclamation	# of Well Pads Achieving Proposed End Land Use and Potentially Ready for Certification	Cumulative # of Well Pads Certified
2045	0	0	0	0	72	4	30
2046	0	0	0	0	72	5	35
2047	0	0	0	0	72	5	40
2048	0	0	0	0	72	5	45
2049	0	0	0	0	72	4	49
2050	0	0	0	0	72	7	56
2051	0	0	0	0	72	3	59
2052	0	0	0	0	72	5	64
2053	0	0	0	0	72	3	67
2054	0	0	0	0	72	5	72

The schedule is based on the following assumptions:

- Each well pad will take two years to construct and start first steam.
- Each well pad will be decommissioned and reclaimed at the end of its life. Canadian Natural assumes each well pad will be in place for 10 years (based on an 8-year operational life) and alternate bitumen recovery technologies will not exist to extend well life.
- Each well pad will take one year to decommission.
- Each well pad will take two years to reclaim.
- Following reclamation each well pad will require 10 years to reach the stage of establishment where reclamation certification is possible.
- Resources will be available to reclaim multiple sites simultaneously.
- Target end land uses will be determined in consultation with ESRD and other stakeholders as part of the final reclamation planning, and will be based on equivalent land capability and forest productivity at a minimum, but will also consider traditional land use, wildlife habitat and recreation.

18. SIR 185, Responses a and b, Pages 410-411
Volume 1, Section 11.8.5.1, Table 11.8-2, Page 11-30
Project Update Section 1.4.3, Table 1.4-3 and 1.4-4, Page 21 and 22

Canadian Natural included Tables 1.4-3 and 1.4-4, for topsoil and subsoil reclamation material balance in the Project Update. Table 1.4-3 lists the Savage Area and Replacement Area of the borrow areas to be equivalent. Canadian Natural notes (Note b) that Replacement area includes areas of soil disturbance with the exception of buried pipelines and open waterbodies on borrow areas.

Table 1.4-4 lists the subsoil Salvage area for roads as 137 ha, while Table 1.4-3 lists the topsoil and peat Salvage area for roads as 88 ha. The subsoil salvage area cannot be more than the topsoil salvage area. The B-horizon salvage for roads is listed as 238,323 m^3. Canadian Natural notes (Note a) Salvage area includes areas of soil disturbance with the exception of buried pipelines, and roads and well pads on deep peat, thus there should be no subsoil available from roads.

Updated replacement volumes (i.e., topsoil replacement for roads has decreased by 45,000 m^3, with a 1 ha area decrease) has changed significantly from the Application Table 11.8-2 to the Project Update Table 1.4-3.Separate the LFH/mineral topsoil and peat volume estimates to provide clarity of reclamation material availability.

a. **Explain why the Salvage and Replacement areas are equivalent if open waterbodies are expected on some of the borrow areas.**

b. **Clarify whether subsoil will not be salvaged on roads, as indicated in Note a of Table 1.4-4, and provide updated information for the subsoil balance on roads.**

c. **Explain the significant change in topsoil replacement volumes between the Application Table 11.8-2 to the Project Update Table 1.4-3.**

d. **Provide update Table 1.4-3 and 1.4-4**

Response:

a. The topsoil, peat and subsoil balances for the Project have been updated in Tables 18-1 and 18-2. In the original tables, it was assumed that soil would be placed across the entire borrow areas at closure. The updated tables reflect Canadian Natural's plans for soil placement only on the marsh and upland areas of the reclaimed borrow areas. Changes in facility disturbance areas compared to the Application are primarily due to footprint changes, including decreased area of borrow as described in Section 1.2.4 of the Project Update (Canadian Natural 2012). Other facility areas have remained the same and minor differences may be due to rounding.

b. Canadian Natural will not be salvaging or placing subsoil on roads. Refer to Tables 18-1 and 18-2 for the updated information. Construction fill material will be decompacted and will act as a subsoil for reclamation of upland ecosites on roads.

c. The topsoil replacement volumes are significantly less in the Project Update because the Project footprint is 31 ha less in size, mostly due to reduction in borrow and laydown areas. Many of the smaller borrow areas which were not planned to be reclaimed to waterbodies and required soil placement across the entire disturbance area, are no longer present in the Project Update. The borrow areas that are left are larger with a larger proportion being reclaimed to open water wetlands.

d. Updated versions of the soil balance tables (Project Update, Tables 1.4-3 and 1.4-4) are provided below as Tables 18-1 and 18-2, respectively. To clarify the differences between the total facility disturbance area and the areas where soil will be salvaged, an additional column has been added in Tables 18-1 and 18-2. The "Facility Disturbance Area" column represents the full extent of the facility disturbance including soil and vegetation disturbance regardless of whether soil is salvaged or not.

Table 18-1 Topsoil and Peat Balance for the Project (Updated)

Project Component	Facility Disturbance Area [ha]	Topsoil/ Peat Salvage Area[(a)] [ha]	Total Mineral Topsoil Available [m^3]	Total Peat Available [m^3]	Total Topsoil/ Peat Available [m^3]	Replacement Area [ha][(b)]	Topsoil/ Peat to Replace[(c)] [m^3]	Balance [+/- m^3]
Plants	71	71	54,328	180,954	235,282	71	162,158	73,124
Well Pads	355	316	250,143	404,365	654,508	355[(e)]	578,229	76,279
Borrow Areas	453	453	473,769	1,617,712	2,091,481	322	615,258	1,476,223
Camps	16	16	12,575	75,136	87,711	16	34,288	53,423
Roads	137	88	100,312	24,423	124,735	137[(e)]	232,670	-107,935
Rights of Way (including pipelines and power lines)	496	0	0	0	0	0	0	0
Water Source	11	7	6,057	1,161	7,218	11[(e)]	20,481	-13,263
Disposal Well	2	1	1,404	695	2,099	2[(e)]	3,256	-1,157
Laydown Area	29	21	21,068	10,134	31,202	29[(e)]	49,759	-18,557
Total	**1,570**	**973**	**919,656**	**2,314,580**	**3,234,236**	**943**	**1,696,099**	**1,538,137[(d)]**

(a) Salvage area includes areas of soil disturbance with the exception of buried pipelines and facilities constructed on fill pads over deep peat.

(b) Replacement area includes areas of soil disturbance with the exception of buried pipelines and open waterbodies on borrow areas.

(c) Topsoil replacement depths will be assumed to be 80% of salvage depths on each Project component. Excess salvaged topsoil due to deep peat excavation will be used in reclamation by increasing placement depths on selected facilities.

(d) Excess topsoil will be spread on Project disturbances as a reclamation material resulting in increased placement depths.

(e) Replacement areas exceed salvage areas because soil will not be salvaged on deep peat, but fill will be left in place at reclamation. Reclamation material will be sourced from other areas of the site to provide appropriate coverage to complete reclamation.

Note: Table 18-1 is an update of Table 1.4-3, which is an update of Table 11.8-2, provided in Volume 1, Section 11.8.5 of the Application.

Table 18-2 Subsoil Balance for the Project (Updated)

Project Component	Facility Disturbance Area [ha]	Subsoil Salvage Area[(a)] [ha]	B Horizon Available [m^3]	Replacement Area[(b)] [ha]	B Horizon to Replace[(c)] [m^3]	Balance [+/- m^3]
Plants	71	50	149,421	71[(f)]	213,947	-64,526
Well Pads	355	171	513,450	355[(e)]	519,740	-6,289
Borrow Areas	453	321	964,238	322	800,842	163,396
Camps	16	8	25,150	16[(f)]	48,000	-22,850
Roads	137	0	0	0	0	0
Rights of Way (including pipelines and power lines)	496	0	0	0	0	0
Water Source	11	6	19,449	11[(e)]	17,597	1,852
Disposal Well	2	1	1,685	2[(e)]	1,685	0
Laydown Area	29	18	49,196	29[(e)]	52,503	-3,307
Total	**1,570**	**575**	**1,722,589**	**806**	**1,654,314**	**68,276**[(d)]

(a) Salvage area includes areas of soil disturbance with the exception of buried pipelines, roads and facilities constructed on fill pads over deep peat.

(b) Replacement area includes areas of soil disturbance with the exception of buried pipelines and open waterbodies on borrow areas.

(c) Subsoil replacement depths will be equivalent to salvage depths on each Project component.

(d) Excess subsoil will be spread on Project disturbances as a reclamation material resulting in increased placement depths.

(e) Replacement areas exceed salvage areas because soil will not be salvaged on deep peat, but fill will be left in place at reclamation. Reclamation material will be sourced from other areas of the site to provide appropriate coverage to complete reclamation.

(f) On the plant sites and camp the replacement area exceeds salvage area because deep peat will be salvaged to depth, but the underlying subsoil will likely not be considered a reclamation material due to poor quality. These sites will be reclaimed as uplands and will; therefore, require subsoil placement at reclamation.

Note: Table 18-2 is an update of Table 1.4-4, which is an update of Table 11.8-3, provided in Volume 1 Section 11.8.5 of the Application.

The “Salvage Area” column in Table 1.4-4 of the Project Update showed the total disturbance area associated with some of the disturbance types, rather than just the areas from which reclamation material is actually planned to be recovered (e.g., soil will not be salvaged from facility areas located on deep peat). This has been corrected so that now the Salvage Areas columns describe only the areas where soil is planned to be salvaged for each facility type. Consistent with the soil salvage information provided in the Conservation and Reclamation Plan (Volume 1, Section 11.8.3 of the December 2011 Application [Canadian Natural 2011]), the salvage area includes areas of soil disturbance with the exception of buried pipelines and facilities constructed on fill pads over deep peat. For the subsoil balance, roads are not included in the salvage area as Canadian Natural does not intend to salvage subsoil from the road beds. The total topsoil salvage areas for the water source wells, disposal wells and laydown areas have been corrected from the values shown in Table 1.4-3 to account for deep peat areas where earthen fill will be placed without peat salvage.

In several cases (e.g., well pads, roads, lay down) the area of soil replacement is equivalent to the total disturbance area, whereas the area of soil salvage is less. This can be attributed to the fact that on these facilities, areas of deep peat will not be salvaged and will be padded with fill material as described above. At the time of reclamation, fill will be left in place and reclamation material will be placed over this fill material to cover the total disturbance area.

In the case of borrow areas, Canadian Natural plans to reclaim large disturbances partially to open water wetlands as described in Volume 1, Section 11.11.4. The replacement area only accounts for those areas that will not be water covered at closure.

On the plant sites and camp, subsoil replacement area exceeds subsoil salvage area because deep peat will be salvaged to depth, but the underlying subsoil will likely not be considered a reclamation material due to poor quality. These sites will be reclaimed as uplands and will, therefore, require subsoil placement at reclamation. This method also applies where shallow peat (considered topsoil) is salvaged on well pads, but both subsoil and topsoil are replaced in order to reclaim to an upland ecosite.

References:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Volumes 1 to 6.* Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

WILDLIFE

19. Page 62, SIR response 19 f

CNRL indicates it does not have any plans to undertake 4-D seismic collection for the Kirby Expansion project.

a. Comment on whether CNRL is using 4D seismic at other CNRL in situ and CSS projects. If so, how does the Kirby project differ and therefore not require 4D seismic?

b. What other method will CNRL use to monitor steam chamber development? Describe the potential impacts associated with these monitoring methods.

Response:

a. To clarify, in the response to Round 1 SIR 19f (Canadian Natural 2012) Canadian Natural did not state it has no plans to undertake four dimensional (4-D) seismic collection for the Project. Canadian Natural stated that there is no immediate plans for 4-D seismic surveys to be conducted for the Project. It is not routine to undertake 4-D seismic surveys for in situ thermal operations and Canadian Natural would only consider them when a need has been identified and value can be demonstrated. A 4-D survey would only be considered in circumstances where investigation of poor SAGD well performance is required to understand operational or reservoir issues. If 4-D seismic was to be conducted it would be done on a pad by pad basis rather than Project wide. Because of the uncertainty regarding the need for 4-D seismic, potential locations for surveys are unknown.

   To date Canadian Natural's Cyclic Steam Stimulation operations have employed 4-D seismic surveys to investigate specific performance questions. These surveys have been done over a small portion of the operating pads and Canadian Natural does not currently see value in 4-D seismic for routine steam chamber surveillance.

b. Canadian Natural will monitor steam chamber development using the following methods:

   - monitoring of daily production data including down-hole pressures and temperatures from horizontal wells on SAGD well pads;
   - metering and analysis of injected and produced fluid volumes at individual SAGD well pairs; and
   - monitoring of temperatures and pressures at observation wells.

The potential impacts associated with the first two listed monitoring methods were considered in the Environmental Impact Assessment (EIA) as they will be conducted on SAGD well pads proposed as part of the Project.

As discussed in the response to Round 1 SIR 19a and 19b Canadian Natural is planning at least one observation well per drainage box for the initial SAGD well pads, but has no current plans for observation wells beyond the initial well pads. These observation wells will gather temperature and pressures from the bitumen reservoir. The specific locations of the monitoring wells are not currently known but existing disturbance/infrastructure will be targeted for use to the extent possible. If new well sites are required the standard dimensions would be 60 m x 90 m (540 m^2), so a total area of 37,800 m^2 (3.8 ha) would be necessary, assuming there are seven observation well sites. This total is less than the area required for a single SAGD well pad, and would represent a 0.2% increase relative to the 1,602 ha Project footprint used for assessment of the terrestrial impacts of the Project in the EIA.

Well site construction and well drilling will occur in the winter using ice roads and ice pads, with minimal soil disturbance. Because the observation wells will be monitored by Supervisory Control and Data Acquisition, which is a remote computer-based control system, minimal ongoing access to the sites will be required once the wells are drilled and the monitoring instrumentation is installed. As a result, construction of earthen fill pads and access roads will not be required, and access to the sites will occur by all terrain vehicle or during winter months when the ground is frozen. Trees and shrubs would be allowed to re-grow on the well sites; however periodic clearing may be required if problems with the monitoring equipment develop and access with a service rig becomes necessary. Based on the above information and implementation of other appropriate mitigation proposed in the EIA, Canadian Natural is confident that the environmental impacts of observation well construction and operation will be negligible and will not change the conclusions of the EIA.

References:

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

20. Page 61, SIR Response 20 g. and Page 12, SIR response c

CNRL states in the context of whether surface heave will affect railway lines that, It is expected that the deeper the reservoir the smaller the surface heave and the shallower the heave slope will be at the surface and predicts the maximum heave and

heave slope… to be 145 mm with maximum slope of 0.00015 m/m (1.5 cm/100 m). Page 62, SIR Response 19 g. CNRL indicates it believes a surface heave monitoring plan is not necessary for the CNRL Kirby Project. Current estimates and actual measurements of surface heave are variable across the industry.

a. The use of the phrase *It is expected* suggests clear data are unavailable to support CNRL's statement. Comment on CNRL's confidence in its predictions of likely surface heave.

b. Comment on CNRL's confidence that surface heave will not influence local hydrology.

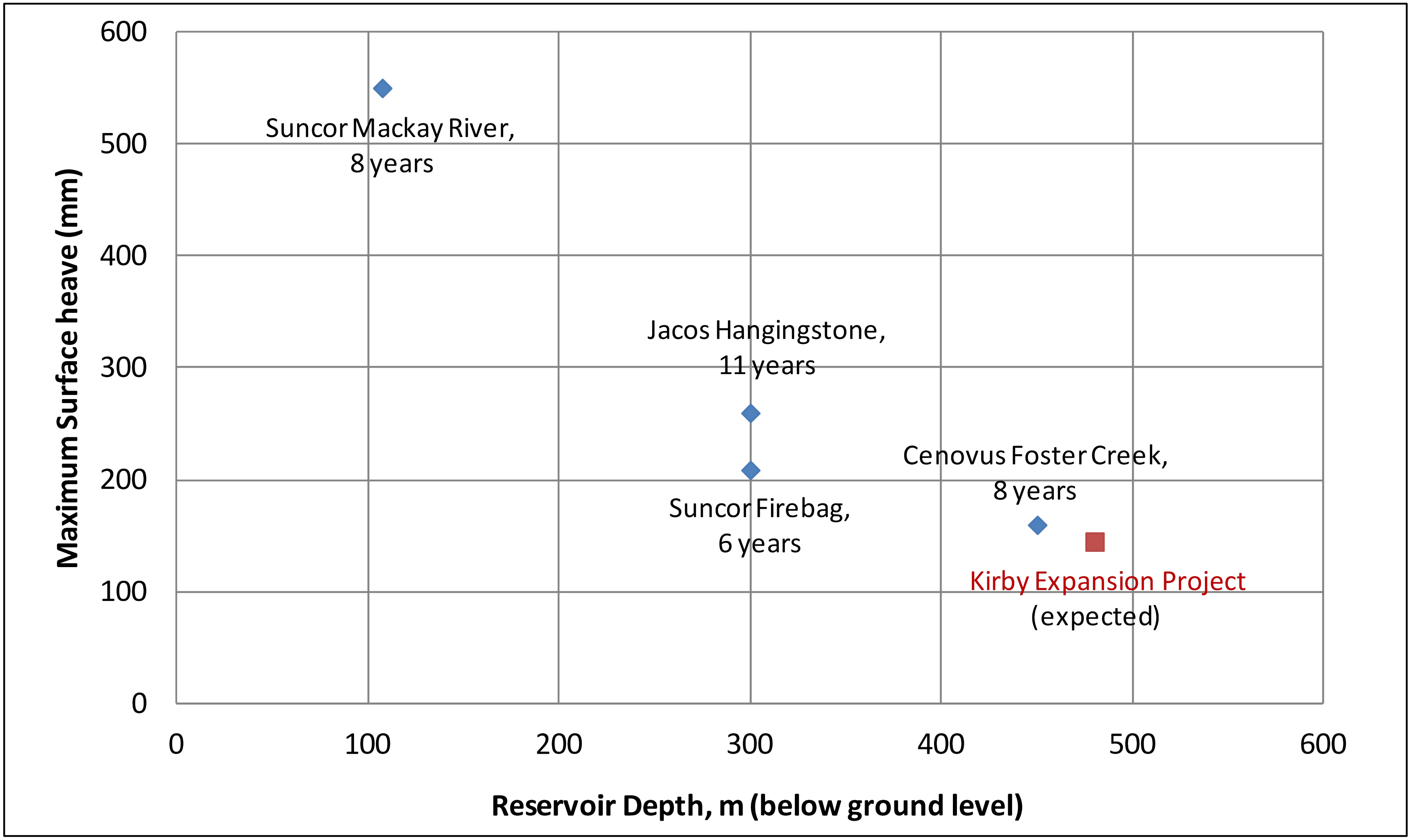
c. If CNRL is not monitoring heave and the potential impacts associated with it, how will CNRL establish that impact predications and 'expectations' are accurate?

Response:

a. Clear data are available to support Canadian Natural's statements. The heave monitoring data and their sources are discussed in the Terrain and Soil Assessment (Volume 5, Section 2.4.4 of the December 2011 Application [Canadian Natural 2011]) and in the responses to Round 1 SIRs 2c and 165c (Canadian Natural 2012). Using the monitoring data, Canadian Natural plotted maximum surface heave and maximum heave gradient against reservoir depth, as well as predicted maximum heave and heave slope for the Project. This plotted information was provided in the responses to Round 1 SIRs 2c and 165c. The plots are repeated here as Figures 20-1 and 20-2, respectively.

Canadian Natural is very confident in the surface heave prediction for the Project for the following reasons:

- The data used for analysis are sourced from ERCB annual reports and were measured data.
- The data used for analysis represent maximum values observed from existing SAGD projects.
- The projects selected represent a wide range of reservoir depths from as shallow as about 100 m below ground level to as deep as 450 m below ground level.
- The projects have been operating for long periods of time (6 to ~11 years).
- The data indicate that the deeper the reservoir, the smaller the amount of surface heave and the shallower the heave slope will be at the ground surface (Figures 20-1 and 20-2, respectively). The reservoir depth at the Project will be greater than the projects from which the data were provided. The Project will also be operated under lower pressure and lower temperature than those projects.



NOTE

This Figure is a duplicate of Round 1 SIR Figures 2-1 and 165-3.

REFERENCE

DATA SOURCE : ERCB ANNUAL REPORT

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

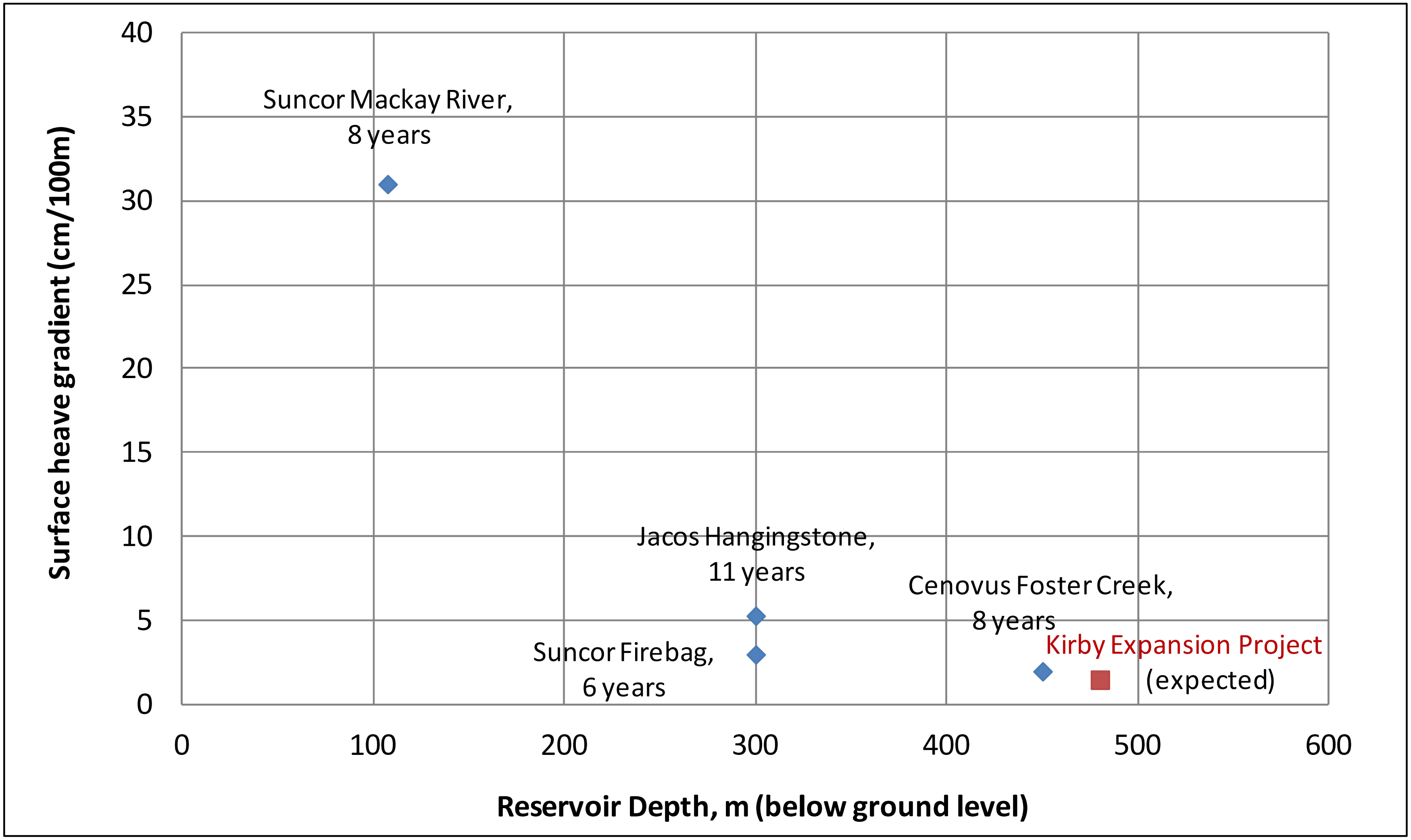
TITLE

MAXIMUM SURFACE HEAVE OBSERVED VERSUS RESERVOIR DEPTH

Canadian Natural

PROJECT	12.1346.0014.5900		FILE No.	12134600145900B001
DESIGN	TGC	13 Aug. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Aug. 2012		
CHECK	TGC	27 Aug. 2012		
REVIEW	JG	27 Aug. 2012		

FIGURE: 20-1



NOTE

This Figure is a duplicate of Round 1 SIR Figures 2-2 and 165-4.

REFERENCE

DATA SOURCE : ERCB ANNUAL REPORT

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

MAXIMUM HEAVE GRADIENT OBSERVED VERSUS RESERVOIR DEPTH

Canadian Natural

PROJECT	12.1346.0014.5900		FILE No.	12134600145900B002
DESIGN	TGC	13 Aug. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Aug. 2012		
CHECK	TGC	27 Aug. 2012	FIGURE: 20-2	
REVIEW	JG	27 Aug. 2012		

Further, based on heave data from monitoring at SAGD projects near Kirby, the predicted maximum and average surface heave over time due to SAGD operations at the Project are plotted in Figure 20-3. The field data show that surface heave due to SAGD operations will occur gradually over time. The maximum surface heave over time that is predicted at the Project is slightly lower than the observed field maximum values at Cenovus Christina Lake and Cenovus Foster Creek because of the deeper reservoir depth, lower operating pressure and lower temperature at the Project. As well, the predicted field maximum surface heave and maximum heave gradient shown in Figures 20-1 and 20-2, respectively, are considered to represent the worst case effect from the Project. Based on the knowledge and experience of the Project geologists and engineers regarding the influence of pressure and temperature on rock mechanics, it is believed the surface heave will decline over time as SAGD well operations at a pad have ceased and the reservoir cools naturally. While monitoring data are not available to quantify the rate of decline, this does not change Canadian Natural's confidence in the predicted maximum heave for the Project and the predicted negligible environmental consequence.

b. Given Canadian Natural's high level of confidence in the predicted negligible environmental consequence related to surface heave (see the response to part a, Volume 5, Section 2.4.4 and the responses to Round 1 SIRs 2c and 165c), Canadian Natural also has a high level of confidence that surface heave will not influence local hydrology.

c. Given Canadian Natural's high level of confidence in the predicted negligible environmental consequence related to ground heave (see the response to part a above, Volume 5, Section 2.4.4 and the responses to Round 1 SIRs 2c and 165c), Canadian Natural believes that heave monitoring is not warranted.

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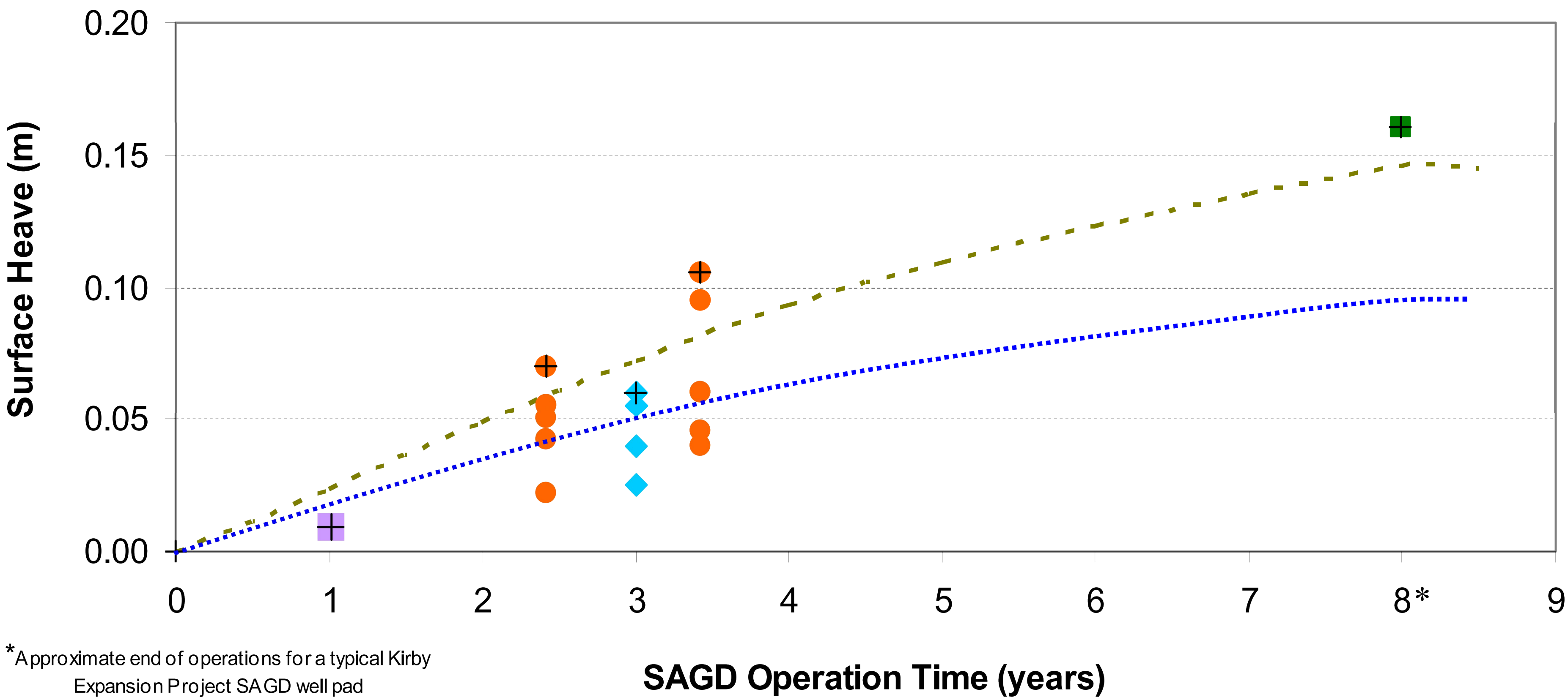

*Approximate end of operations for a typical Kirby Expansion Project SAGD well pad

LEGEND

- Kirby Expansion Project Predicted Maximum Heave (reservoir depth 480 m)
- Kirby Expansion Project Predicted Average Heave (reservoir depth 480 m)
- Devon Jackfish (reservoir depth 415 m)
- StatOil Leismer (reservoir depth 429 m)
- Cenovus Christina Lake (reservoir depth 370 m)
- Cenovus Foster Creek (reservoir depth 450 m)
- + Field Max Value

REFERENCE

DATA SOURCE : ERCB ANNUAL REPORT

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

KIRBY EXPANSION PROJECT PREDICTED SURFACE HEAVE VERSUS TIME

Canadian Natural

PROJECT	12.1346.0014.5900		FILE No.	12134600145900B004
DESIGN	TGC	13 Aug. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Aug. 2012		
CHECK	MD	14 Dec. 2012	**FIGURE: 20-3**	
REVIEW	SM	14 Dec. 2012		

References:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project Application for Approval*. Submitted to Energy Resources Conservation Board and Alberta Environment and Water. December 2011. Calgary, AB.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

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21. Page 259, SIR Response 124

CNRL argues that dissolved nutrients are expected to be assimilated by plants within and downslope of the discharge area.

a. Given the volumes proposed, provide further details on how this may change natural conditions in the area within which the discharge will flow. Comment specifically on changes in vegetation as a consequence of the change in nutrient and natural water regime.

Response:

a. During the life of the Project, effluent from the wastewater treatment system will be tested to meet the required standard for disposal. If the requirements are met, treated water will be discharged to vegetated upland areas using a diffuser system at six discharge points within 150 m around the perimeter of the camp. The associated sludge will be trucked to an approved facility (Volume 2, Section C.12 of the December 2011 Application [Canadian Natural 2011]). The final treated effluent is expected to be of a quality that will not result in adverse effects on vegetation in the discharge areas. The proposed on-site wastewater treatment system includes secondary biological treatment and membrane ultrafiltration, similar to what is currently being used for the Kirby South 2010 (KS1) construction camp. (Volume 1, Sections 5.1.3.3 and 8.8.5 [Canadian Natural 2011]; Round 1 SIR Response 124, [Canadian Natural 2012]). These on-site treatment systems will meet the *Alberta Private Sewage System Standards of Practice 2009* (Government of Alberta 2009). A third-party contractor will design, build and operate the wastewater treatment facilities for the Project, and will obtain the necessary licenses and *Environmental Protection and Enhancement Act* (EPEA) approvals on behalf of Canadian Natural (Volume 1, Sections 5.1.3.3 and 8.8.5).

While treated wastewater discharge is not expected to cause adverse effects to vegetation, small shifts in understorey species composition and community structure could potentially occur due to changes in the nutrient and water regime (Bayley et al. 1985; Daoust and Childers 2004; Thormann and Bayley 1997). Effluent from treated domestic wastewater is often of equal or greater quality to the water naturally entering wetlands (Kadlec and Wallace 2009). A discussion of the potential outcomes of increased water volumes and nutrient concentrations is provided below.

Increased Water Volume

During the peak construction period (Q4 2014), the peak weekly discharge flow is conservatively expected to be 1,978 m^3 based on the peak onsite and offsite workforce (Round 1 SIR Response 124). If this volume of discharge was conservatively assumed to occur weekly throughout the year, the additional volume is comparable to the difference in precipitation between an average year and a 1 in 100 wet year[1], if spread equally over the perimeter around the camp (approximately 47 ha). It is unlikely that the added water will dramatically increase infiltration rates, and most of the water will instead run off to low-lying areas. The increased moisture levels within these low-lying areas will likely result in increased evaporation and evapotranspiration, depending on the topography of the release area.

The land cover types located within 150 m of the camp include burned uplands (BUu), burned wetlands (BUw), shrubby fen (FONS), wooded fen (FTNN) and disturbances (DIS)(Table 21-1). Effluent will likely be discharged within the burned upland (BUu) land cover type where sufficient vegetation cover is present to mitigate erosion. Discharge of effluent to upland areas, may cause temporary increases in moisture levels resulting in shifts to hydrophytic species in the understorey (species adapted to wetlands conditions). However, it is more likely that water will run-off into low-lying areas and thus shifts to vegetation communities due to discharge are not expected within uplands.

Soils plot data within the upland areas located within 150 m of the camp range from moderately well to imperfectly drained sites. Based on these soils data, water is unlikely to pool in upland areas and, as identified above, water will most likely to flow down slope into wetlands. Wetlands and riparian areas are naturally adapted to fluctuations in water levels (Luke et al. 2007; Kadlec and Wallace 2009). In addition, tree species have deep and well-established root systems, which are expected to compensate for the effects of moderate fluctuations in the water table (Murphy et al. 2009). Therefore, tree species composition is not expected to change as a result of the discharge.

[1] From Table 4.1, Golder (2003) based on 1953 to 1999 rainfall data; mean regional average precipitation for upland terrain is 486 mm, 1:100 wet year is 720 mm, difference is 234 mm.

Table 21-1 Summary of Baseline Vegetation Types within 150 m Perimeter of the Camp

Land Cover Type	Description	Area	
		[ha]	% of 150 m Perimeter Area
Upland Vegetation			
BUu	burned uplands	21	44
	terrestrial subtotal	*21*	*44*
Wetlands			
FONS	shrubby fen	<1	1
FTNN	wooded fen	4	8
BUw	burned wetlands	10	21
	wetlands subtotal	*14*	*30*
Disturbances			
DIS	disturbance	12	26
	disturbances subtotal	*12*	*26*
Total		**47**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Increased Nutrient Concentrations

Dissolved nutrients are expected to be assimilated by plants within and downslope of the discharge areas (Round 1 SIR Response 124). The vegetation community composition within each wetlands type in the boreal forest can potentially be influenced by changes to parameters such as acidity (pH), nutrient availability and conductivity (Mulligan and Gignac 2001; Vitt and Chee 1990). Vegetation community responses to alteration in nutrients are both species-specific and site dependent (Thormann and Bayley 1997). The list below provides typical concentrations and constituents associated with effluent of wastewater that has been treated with secondary biological treatment and membrane infiltration:

- five-day biochemical oxygen demand (BOD_5) less than 10mg/L;
- total suspended solids (TSS) less than 10mg/L;
- ammonia less than 0.2 mg/L;
- nitrogen less than 0.5 mg/L; and
- phosphorus approximately 4.0 mg/L, range 2 to 8 mg/L.

As water will likely be discharged into burned upland areas, soil texture and drainage will determine the rate at which nutrients flow downslope. If the discharged water pools in uplands and is absorbed into the local soils, there may be a shift to increased populations of species adapted to higher nutrient conditions and a reduction of species adapted to lower nutrient conditions (see Thormann and Bayley 1997 for specific species responses to additions of nitrogen and phosphorous). There may also be an increase in the biomass (i.e., percent cover) of vegetation, in cases where nutrients had originally limited growth (Kadlec and Wallace 2009; Silvan et al. 2003). However, as stated above the soils data for upland areas within 150 m of the camp indicate moderately well to imperfect drainage. It is expected that most of the discharged water will run-off into low-lying wetlands. In addition, given the low discharge nutrient concentrations, vegetation community shifts are expected to be minimal.

Effects of increased nutrients within wetlands will depend on the type of wetland present and the amount of mobile nutrients. As stated above, the wetlands located within 150 m of the construction camp include the burned wetlands (BUw), the shrubby fen (FONS) and the wooded fen (FTNN) wetlands types (Table 21-1). The nutrient regime of the burned wetlands (BUw) wetlands type is variable and may range from poor to rich depending on the original wetlands type present before being burned. In poorer peatlands such as bogs and poor fens (i.e., nutrient poor), there may be a shift to species typically associated with nutrient rich fens and marshes (see Halsey et al. 2003 for species associated with these wetlands types). Increased water input, ammonia, nitrogen and phosphorous will likely initially increase net primary productivity (NPP) of *Sphagnum* moss and shrubs. Bryophytes will begin to decline if they become N-saturated, and *Sphagnum* moss dominated systems will be more sensitive than rich fen areas (Gunnarsson and Rydin 2000). In rich wetlands such as rich marshes, fens or swamps (i.e., nutrient rich), there will likely be a less noticeable shift in the species. Through processes including microbial interaction, sedimentation, filtration, soil adsorption and chemical precipitation, wetlands have adapted to dissolving and assimilating nutrients and are able to breakdown and precipitate pollutants into benign products and useable nutrients (Kadlec and Wallace 2009).

References:

Bayley, S.E., Jr.J. Zoltek, A.J. Hermann, T.J. Dolan and L. Tortora. 1985. *Experimental manipulation of nutrient and water in a freshwater marsh: Effects on biomass, decomposition, and nutrient accumulations.* Limnology and Oceanography. 30(3): 500-512.

Canadian Natural (Canadian Natural Resources Limited). *2011. Application for Approval of the Kirby In Situ Oil Sands Expansion Project. Volumes 1 to 6.* Submitted to the Energy Resources Conservation Board and Alberta Environment. December 2011.

Canadian Natural. 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. August 2012.

Daoust, R.J. and D.L. Childers. 2004. *Ecological effects of low-level phosphorus additions on two plant communities in a neotropical freshwater wetland ecosystem. Occologia*. 141: 672-686.

Government of Alberta. 2009. *Alberta Private Sewage Systems Standard of Practice. Alberta Municipal Affairs.* Environmental Health Department. Peace Region Health. Grande Prairie, AB.

Golder (Golder Associates Ltd.). 2003. *Calibration of the HSPF water quality model for the oil sands region in northeastern Alberta*. January 2003. Calgary, AB. 36 pp.

Gunnarsson, U. and H. Rydin. 2000. *Nitrogen fertilization reduces Sphagnum production in bog communities.* New Phytologist 147: 527-537

Halsey, L.A., D.H. Vitt, D.W. Beilman, S. Crow, S. Mehelcic and R. Wells. 2003. *Alberta wetlands inventory standards, version 2.0*. Alberta Sustainable Resource Development, Resource Data Branch. Edmonton, AB. 54 pp. ISBN: 0778523233 (print) 0778523241 (online).

Kadlec, R.H. and S.D. Wallace. 2009. *Treatment Wetlands (Second Edition).* CRC Press. Boca Raton, Florida. 945- Appendices pp.

Luke, S.H., N.J. Luckai, J.M. Burke and E.E. Prepas. 2007. *Riparian areas in the Canadian boreal forest and linkages with water quality in streams*. Environ. Rev. 15: 79-97.

Mulligan and Gignac. 2001. *Bryophyte community structure in a boreal poor fen: reciprocal transplants*. Canadian Journal of Botany. 79: 404-411.

Murphy, M., R. Laiho and T.R. Moore. 2009. *Effects of water table drawdown on root production and aboveground biomass in a boreal bog*. Ecosystems 12: 1268-12-82.

Silvan, N., H. Vasander and J. Laine. 2003. *Vegetation is the main factor in nutrient retention in a constructed wetland buffer.* Plant and Soil. 258: 179-187.

Thormann, M.N. and S.E. Bayley. 1997. *Response of aboveground net primary plant production to nitrogen and phosphorus fertilization in peatlands in southern boreal Alberta, Canada*. 17(4): 502-512.

Vitt, D.H. and W.L. Chee. 1990. *The Relationship of Vegetation to Surface Water Chemistry and Peat Chemistry in Fens of Alberta, Canada*. Vegetation. 89:87-107.

22. Thermal plumes and arsenic

a. **Page 279, SIR Response 128 a. CNRL was requested for information on the toxicities of the arsenic species present. The response indicates that arsenate and arsenite are present; but, with respect to toxicity states only that *Arsenite is considered to be the more toxic of the two species.* Provide an expanded account of the toxicities of the arsenic species present.**

b. **Page 279, SIR Response 128 b. CNRL indicates they expect thermal plume development to be somewhere between the Devon and Encana predictions presented in the response (interpreted as 100 metres to 700 metres). Given this, CNRL's hydrogeology assessment, geology data, and the local hydrology, provide a rough map of the potential 100 metre and 700 metre extent of thermal plumes associated with the project layout and the local hydrology. Highlight any areas of potential interaction between the hydrology and the potential plume extent.**

c. **Page 279, SIR Response 128 b. CNRL indicates it will undertake an assessment of the potential for arsenic liberation at pad F as part of the groundwater monitoring plan. Given the response to b above, are there other pads where monitoring should be initiated early to better understand thermal plume development and potential arsenic loading in advance of any potential interactions with surface water and to permit mitigation to be developed and implemented if necessary? If so, identify the candidate pads.**

d. **Page 279, SIR Response 128 f. CNRL indicates *mitigative actions such as the development of a hydraulic barrier through groundwater pumping could be undertaken.* Provide further information on mitigation options that could be implemented to prevent the intersection of thermal plumes with surface water. Clearly describe the mitigation measure, its effectiveness, and the time required for implementation.**

Response:

a. Arsenic can exist in four oxidation states in freshwater environments: arsenite (As(III)), arsenate (As(V)), monomethyl arsenate (MMAs(V)), and dimethylarsenate (DMAs(V)), of which arsenate and arsenite are the most common. Arsenite typically occurs in low dissolved oxygen conditions but is relatively unstable in well-oxygenated waters and will rapidly oxidize to arsenate, with the result that arsenate predominately exists in most surface waters. The speciation of arsenic in freshwater is strongly controlled by redox potential of the medium while the availability is influenced by the presence of iron oxyhydroxides (Senn and Hemond 2004), which have been shown to be effective scavengers of arsenic, rendering arsenic unavailable for bioactive interactions with aquatic organisms. As discussed in the response to Round 1 SIR 128 (Canadian

Natural 2012) the ratio of arsenite to arsenate for groundwater samples taken at the Kirby South CPF site showed an approximate 4:1 arsenite to arsenate ratio.

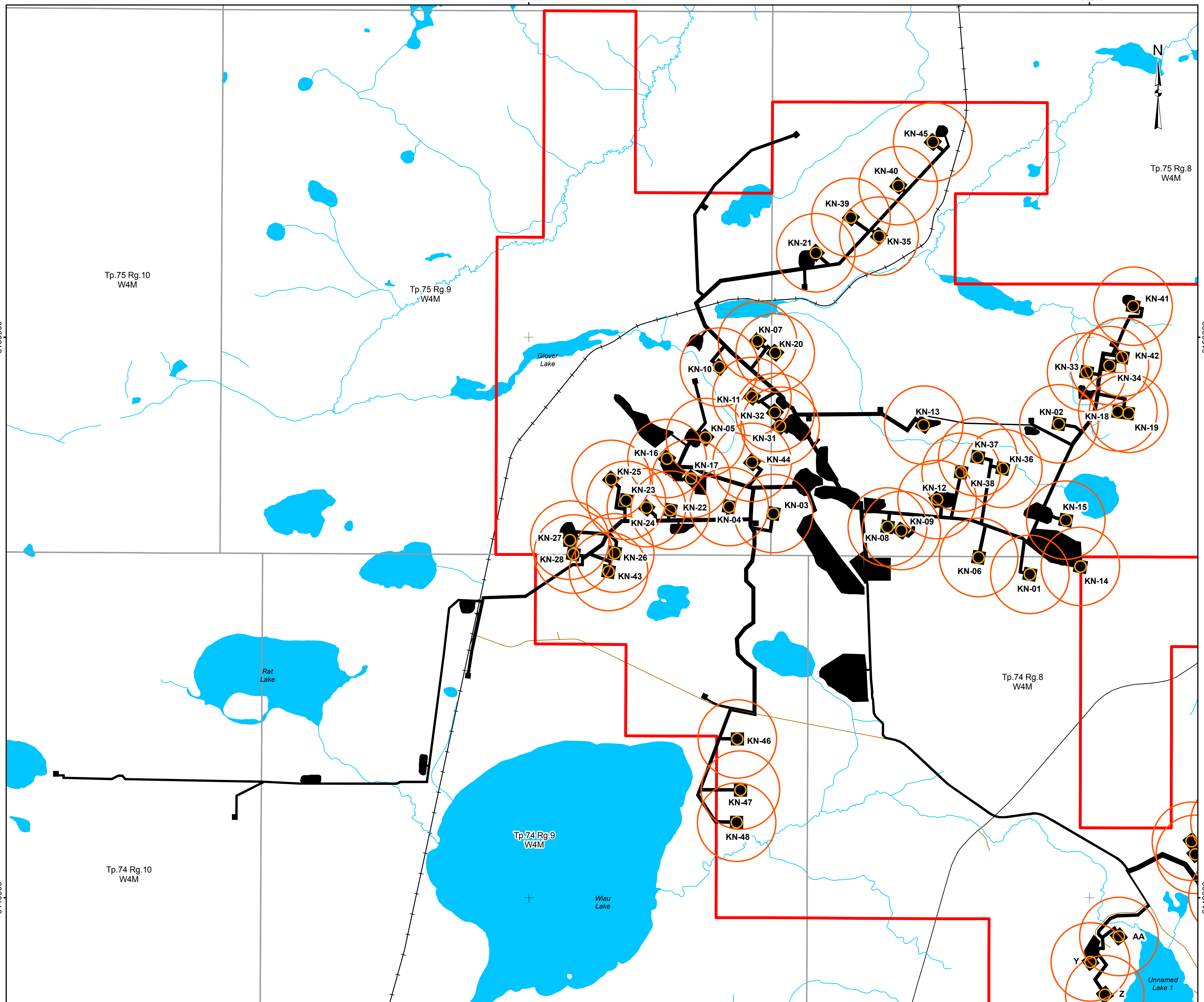
In surface water environment, the presence of natural organic matter has also been shown to strongly influence arsenic mobility in freshwater (Redman and Macalday 2003). Buschmann et al. (2006) found that arsenate was bound more strongly to dissolved organic carbon (e.g., humic and fulvic acids) than arsenite, a result that was unaffected by pH. Arsenite generally sorbs to, and co-precipitates with other metal sulphides, while arsenate typically sorbs to iron and aluminum hydroxides (Ritter et al 2006; Senn and Hemond 2004). Arsenic can also be biologically transformed to methyl species, with bacteria acting as mediating agents (Faust et al. 1987). Arsenite reduction was reportedly mediated by bacteria, fungi and algae (Faust et al. 1987).

Some studies (Senn and Hemond 2004) have indicated that arsenic released to overlying water from sediments occurs predominantly complexed to particulate matter. Arsenic in the water column also exhibits a strong affinity for particulate organic matter (operationally defined as organic matter larger than the 0.45 μm filter pore size), and complexation with dissolved and particulate organic matter are responsible for removal of most arsenic in surface waters.

The available data for arsenic indicate that in surface waters arsenic will tend to be present mainly as complexed species or bound to dissolved or particulate organic matter. While arsenite concentrations are typically higher in groundwater as compared to arsenate, this is expected to change as groundwater discharges to surface waters. As noted above, under circum-neutral pH conditions and high redox potential conditions, as would typically occur in surface waters, arsenite is expected to be rapidly oxidized to arsenate.

A detailed discussion of the toxicity of arsenic in the surface water environment is discussed in the response to Round 2 SIR 31.

b. The Project thermal well pads are identified in Figures 22-1 and 22-2. Using the data available to present thermal plume configurations on the map will result in an inaccurate and misleading portrayal of potential plume size and migration direction. Instead, circles defined by radii of 100 m and 700 m centered on each well pad are presented in the Figures to represent minimum and maximum distances of predictive thermal plume development. In the presence of continuous aquifers, it is expected that thermal plumes could develop and flow down-gradient of individual pads.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- 100 METRE WELL SITE BUFFER
- 700 METRE WELL SITE BUFFER
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- PROPOSED KIRBY EXPANSION PROJECT FOOTPRINT

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED) AND FROM IHS ENERGY INC.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

3 0 3

SCALE 1:70,000 KILOMETRES

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

KIRBY NORTH 100 AND 700 METRE WELL SITE BUFFERS

Canadian Natural

PROJECT	12-1346-0014	FILE No.	
DESIGN	CM	12 Jun. 2012	SCALE AS SHOWN / REV. 4
GIS	SS	21 Nov. 2012	
CHECK	DE	20 Nov. 2012	FIGURE: 22-1
REVIEW	SM	20 Nov. 2012	

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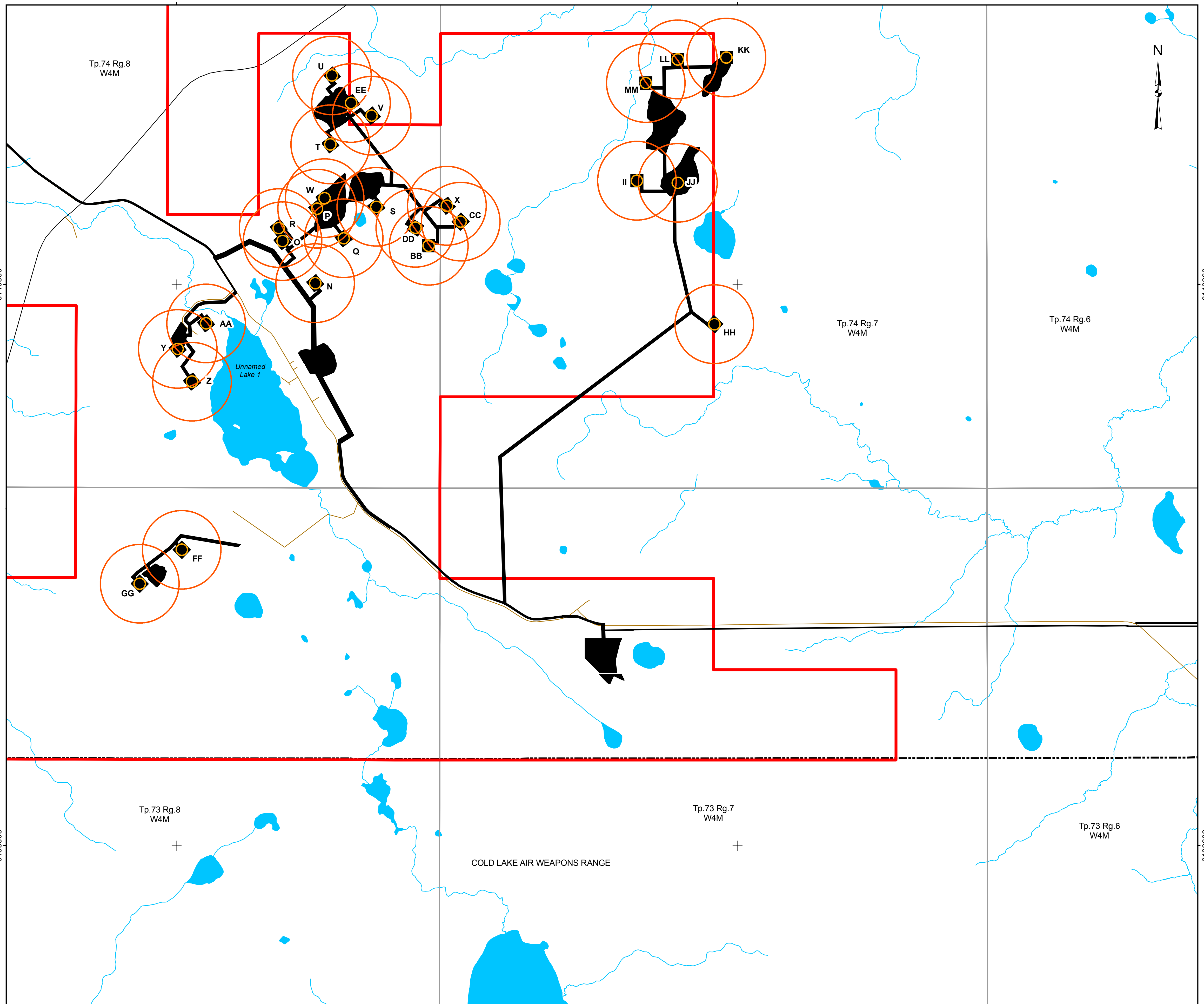

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- 100 METRE WELL SITE BUFFER
- 700 METRE WELL SITE BUFFER
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- PROPOSED KIRBY EXPANSION PROJECT FOOTPRINT

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED) AND FROM IHS ENERGY INC.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

3 0 3

SCALE 1:70,000 KILOMETRES

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

KIRBY SOUTH 100 AND 700 METRE WELL SITE BUFFERS

Canadian Natural

PROJECT		12-1346-0014	FILE No.
DESIGN	CM	12 Jun. 2012	SCALE AS SHOWN REV. 4
GIS	SS	21 Nov. 2012	FIGURE: 22-2
CHECK	DE	20 Nov. 2012	
REVIEW	SM	20 Nov. 2012	

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As can be seen in the figures, in some cases the 700 m radius circles intersect surface waterbodies. As discussed in the responses to Round 1 SIRs 128d and 241 and Round 2 SIR 27, the potential for the migration of thermal plumes from pads to surface waterbodies is not expected across the Project Area due to the shallow nature of most of the surface water features in the Project Area and the expected absence of continuous shallow aquifers which would act as pathways for migration. A possible exception to this, noted in the response to Round 1 SIR 128d, is the area around Edwards Lake and Sunday Creek. As discussed in the response to Round 1 SIR 128d, these waterbodies are deeper and the Sand River Formation aquifer may be continuous between select pads and the water features. For this reason, Canadian Natural has committed to placing wells on the downgradient edge of Pads KN-07, KN-20 and KN-35 to assess the geology and the potential presence of thermal plume migration (Round 1 SIR response 128d).

c. Canadian Natural will conduct an assessment similar to the proposed Pad F assessment of the potential for thermal and dissolved arsenic plume development at one of the initially drilled and produced Kirby North (KN) Pads. Tables 1.2-2, 1.2-3, and 1.2-4 included in Project Update (Canadian Natural 2012), present the well pad construction and drilling schedule for the Project. The well pad locations are presented in Figures 22-1 and 22-2. The KN pad sites are identified numerically, and ordered based on the current construction and drilling schedule. Pads KN-1 to 6 are scheduled to be in place for KN start-up. One of these pads will be selected for an assessment similar to that which will be carried out at Pad F at Kirby South 2010. Details on the selected pad and the proposed program will be included in the groundwater monitoring proposal which will be developed in consultation with ESRD following Project approval.

   In addition, in the response to Round 1 SIR 128d Canadian Natural has committed to investigating the potential for thermal and dissolved arsenic plume development at Pads KN-07, KN-20 and KN-35 which are up-gradient of Edwards Lake and Sunday Creek where the Sand River Formation may act as a pathway between the pads and the water features.

d. Canadian Natural is not aware of any thermal plume mitigation systems operated by in situ oil sands operators. Two potential options that could be considered in the prevention of the intersection of a thermal plume with surface water include hydraulic capture and source control as discussed below.

   Hydraulic Capture: Hydraulic capture is considered a proven technology, and the concept is considered technically and practically feasible. To effectively implement a hydraulic capture mitigation program, the aquifer hydraulic characteristics and the extent of thermal plume development must be well defined. This would require an investigation phase to characterize the aquifer and plume in sufficient detail to allow for effective program design. Based on the physical characteristics of the aquifer and plume, analytical or numerical techniques could be used to complete a capture zone analysis. The program would include the construction and testing of groundwater extraction wells whereby the potential thermal plume is captured and the groundwater is diverted to treatment or disposal. A thermal plume hydraulic capture (and treatment) mitigation program can be assessed and implemented within a few months. All non-saline groundwater diversion for remedial purposes must be approved by ESRD under the *Water Act* (Government of Alberta 2000). Given that regulatory approvals are required, the timing for the implementation of this mitigation program will be influenced by ESRD's regulatory timelines. Thermal plumes are expected to travel at estimated rates of less than 10 to 50 m per year providing ample time for system development.

Thermal Plume Source Control: The use of production casing insulation has been contemplated by in situ oil sands operators in the context of reducing heat loss from thermal injection and production wells. It is possible that some of these technologies may be employed to prevent thermal plume development and to slow plume migration toward surface waterbodies.

In the case where shallow aquifers are present and may act as a pathway from a pad to surface water feature (e.g., potentially Pads KN-07, KN-20 and KN-35) using insulated casing where the wells intersect a shallow aquifer may prevent the development of a thermal plume.

As this approach is considered proactive, the mitigation plan would need to be implemented during the construction of SAGD wells (and therefore before the first steaming event). It is not known if this technology has been utilized by other operators to prevent the development of thermal plumes. As a result, its effectiveness is still unproven.

References:

Buschmann, J., A. Kappeler, U. Lindauer, D. Kistler, M. Berg and L. Sigg. 2006*. Arsenite and Arsenate Binding to Dissolved Humic Acids*: influence of pH, Type of Humic Acid, and Aluminum. Environ. Sci. Technol. 40: 6015-6020.

Canadian Natural (Canadian Natural Resources Limited). 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Faust, S.A., A.J. Winka and T. Belton. 1987. *An Assessment of Chemical and Biological Significance of Arsenical Species in the Maurice River Drainage Basin (N.J.).* Part 1. Distribution in Water and River and Lake Sediments. J. Environ. Sci. Health, **A22**(3): 209-237.

Government of Alberta. 2000. *Water Act.* Revised Statutes of Alberta 2000, Chapter W-3. Current as of March 15, 2012.

Redman, A. and D. Macalady 2003. *Speciation of Inorganic Arsenic in Natural and Synthetic Waters: Redox Transformations and Ligand-Metal Complexation*. SETAC 24th Annual Meeting, Poster Presentation.

Ritter, K., G.R. Aiken, J.F. Ranville, M. Bauer and D.L. Macalady. 2006. *Evidence for the Aquatic Binding of Arsenate by Natural Organic Matter – Suspended Fe(III).* Environ. Sci. Technol. 40: 5380-5387.

Senn, D.B. and H.F. Hemond. 2004. *Particulate Arsenic and Iron During Anoxia in a Eutrophic, Urban Lake. Environ.* Toxicol. Chem. 23 (7): 1610-1616.

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23. Page 330, SIR Response 146 k

CNRL was requested for a map highlighting all areas where a 100 metre setback from the top of the escarpment of watercourses and the high water mark of waterbodies will be encroached upon. The maps provided and referenced in the response present setbacks from the high water mark for both waterbodies and watercourses. Further, areas of encroachment have not been highlighted as requested (e.g., borrow pit in approximately 19-73-7 w4m appears to be within the setback and is not highlighted).

a. Provide a map highlighting all areas where a 100 metre setback from the top of the escarpment for watercourses is encroached upon.

Response:

a. In the absence of an ESRD definition for "top of the escarpment", Canadian Natural has assumed it is synonymous with the definition for "valley break" in the *Integrated Standards and Guidelines. Enhanced Approval Process* (EAP; Government of Alberta 2012). Based on Canadian Natural's extensive field survey experience in the proposed Kirby Expansion Project Area, watercourses in the Project Area are not generally associated with defined valley breaks.

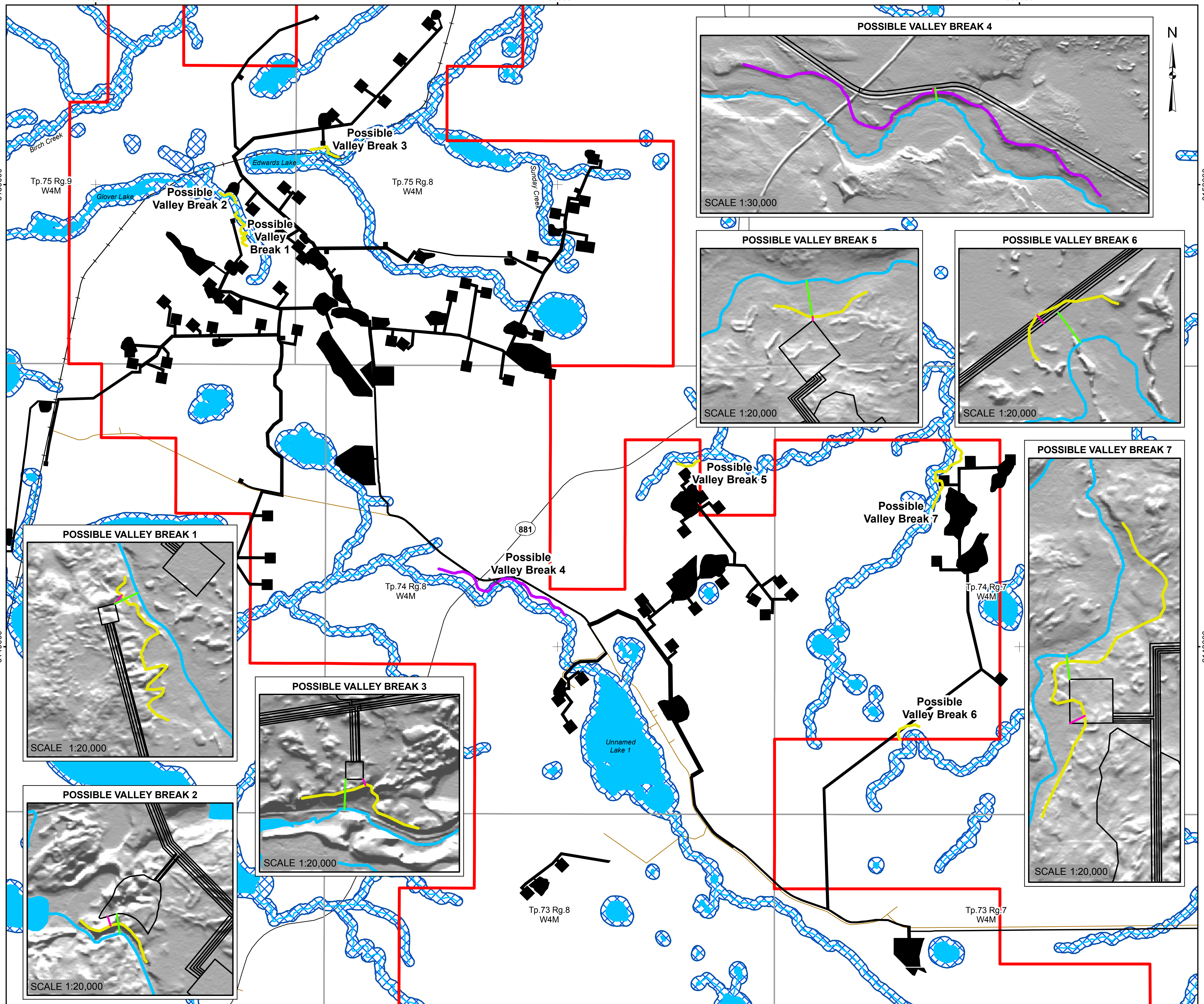
Using LiDAR based hill shade mapping of the proposed Project Area, Canadian Natural has identified seven locations where there are proposed Project facilities and infrastructure within 100 m of a possible valley break associated with a watercourse (Table 23-1 and Figure 23-1). Figure 23-1 provides hill shade mapping and the measured distances from the edge of the Project footprint to the possible valley break and to the mapped edge of the watercourse at each of the seven locations. One of the Project facilities/infrastructure identified in Table 23-1 is a proposed borrow area, located in approximately 13-75-09 W4M. There is no borrow area planned for the Project in approximately 19-73-7 W4M as suggested in the SIR. The only borrow areas in 73-7 W4M are for the approved Kirby South 2010 project.

Table 23-1 Locations Where There are Possible Valley Breaks Associated with Watercourses, and Proposed Project Facilities and Infrastructure are within 100 m of the Breaks

Possible Valley Break ID (Figure 23-1)	Name of Water Feature	Project Facilities/Infrastructure	Location		Shortest Distance		Watercourse Characteristics Description of Location and Justification
			Easting [m]	Northing [m]	Footprint to Watercourse[(a)] [m]	Footprint to Possible Valley Break[(b)] [m]	
1	unnamed tributary	water source well	483162	6149015	128	55	measured width at downstream survey point is 2.3 m, with impoundments
2	unnamed tributary	borrow area KNB3	482892	6149750	100	49	measured width of 2.3 m, with impoundments
3	Sunday Creek	water source well	484964	6150735	151	31	measured width at downstream survey point is approximately 5.7 m; there is an existing railway between the water source well and the watercourse
4	unnamed tributary	interplant pipeline corridor	488824	6141300	94	30	measured width at crossing KS003 (upstream) is approximately 5 m; the footprint is planned to run parallel to an existing road and the road is between the Project footprint and the watercourse
5	unnamed tributary	SAGD well pad U	492834	6143944	205	20	measured width at downstream survey point is approximately 6.5 to 7 m
6	unnamed tributary	in-field corridor	497534	6138214	189	-54	measured width at downstream survey point is approximately 6.2 m
7	unnamed tributary	SAGD well pad MM	498409	6143770	120	-85	measured width is approximately 2.8 m, with impoundments

(a) This distance represents the shortest distance between edge of the Project footprint component and the mapped edge of the watercourse (Figure 23-1).

(b) This distance represents the shortest distance between the edge of the Project footprint component and the proposed valleybreak (Figure 23-1). Negative numbers indicate that the valley break overlaps with the Project footprint or that the Project footprint is closer to the mapped edge of the watercourse than the possible associated valley break.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- PROPOSED KIRBY EXPANSION PROJECT FOOTPRINT
- OPEN WATER
- 100 m SETBACK
- SHORTEST DISTANCE - PROJECT FOOTPRINT TO POSSIBLE VALLEY BREAK
- SHORTEST DISTANCE - PROJECT FOOTPRINT TO WATERCOURSE
- TOP OF SLOPE
- TOP OF SLOPE (ADJACENT TO EXISTING DEVELOPMENT)

NOTE

*OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED) AND FROM IHS ENERGY INC.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

3 0 3
SCALE 1:85,000 KILOMETRES

PROJECT
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
LOCATIONS WHERE PROJECT FOOTPRINT IS WITHIN 100 METRES OF POSSIBLE WATERCOURSE VALLEY BREAKS

Canadian Natural

PROJECT		12-1346-0014	FILE No.	
DESIGN	TGC	01 Nov. 2012	SCALE AS SHOWN	REV. 4
GIS	SS	14 Dec. 2012		
CHECK	TGC	14 Dec. 2012	FIGURE: 23-1	
REVIEW	SM	14 Dec. 2012		

I:\CLIENTS\CNRL\12-1346-0014\mapping\mxd\SIR\Round_2_Figures\Final\1213460014_ValleyGap_11x17_Insets_20121210.mxd

During final siting of Project facilities and infrastructure identified in Table 23-1, Canadian Natural will conduct ground-truthing of the locations to confirm the presence/absence of valley breaks. Although valley breaks are not anticipated, if they are identified and the Project facilities/infrastructure are within 100 m, Canadian Natural will work with ESRD to discuss appropriate setbacks and mitigation, including the applicability of the EAP standards (Government of Alberta 2012), on a site-specific basis, to minimize the potential effects to the watercourse.

References:

Government of Alberta. 2012. *Integrated Standards and Guidelines. Enhanced Approval Process*. July 16, 2012. 47 pp. + Appendices.

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24. Page 336, SIR Response 148 a

CNRL indicates a high pressure release of produced fluid will have a very low potential to occur on Kirby Expansion Project wellheads, and describes mechanisms to prevent these occurrences and potential responses if an event were to occur. Other operators have experienced high pressure releases that aerosolized bitumen and other constituents over a broad area, in one case into a stream bearing arctic grayling and in another a recreational fish-bearing lake.

a. **Given this has occurred in operations using similar technology, to that proposed by CNRL. Does CNRL's project differs from these in its ability to prevent and manage such events?**

b. **Are there additional engineering solutions that might be implemented? If so, please describe.**

c. **If an event were to occur, estimate the response time between identifying the issue and terminating the flow.**

d. **Given the response time noted above and the likely operating pressures, what is the range of volumes and distance that might be affected beyond the wellpad?**

Response:

a. Canadian Natural cannot comment on how the Project differs from these other projects. Although the technology proposed by Canadian Natural may be similar, each Project has unique circumstances that govern operations. Canadian Natural does not have information regarding the prevention and mitigation measures these projects may have had in place or the circumstances that led to these events. Canadian Natural is confident in its ability to prevent and manage potential high-pressure fluid releases. These prevention and management techniques are described in the response to part b.

b. As discussed in the response to Round 1 SIR 148 (Canadian Natural 2012), due to the robust prevention and management measures planned for the Project, there is a low likelihood of a high-pressure release occurring. The engineering solutions related to wellhead failure prevention that Canadian Natural has identified during Project planning and will be implementing includes:

- Design and construction of wellheads will comply with current American Petroleum Institute 6A (American Petroleum Institute 2010) and Industry Recommended Practices 3 and 5 (Enform 2008) specifications.
- Sand control mechanisms will be used to reduce the likelihood of sand erosion. A slotted liner or sand screen will be used to minimize solids production therefore minimizing erosional wear on the wellhead. Canadian Natural will operate all SAGD production wells with a fluid level above the lateral section of the producer well (steam trap control). This practice helps ensure steam production does not occur, as production of steam can lead to wear on wellheads and surface piping. If sand production or a significant failure of the slotted liner occur, then the bottom hole pump will fail, therefore stopping fluid production to surface. Therefore use of a bottom hole pump for an artificial lift mechanism will proactively prevent erosional problems on the wellhead.
- Downhole temperature monitoring on all SAGD production wells will be implemented to monitor fluid temperatures, which will help maintain wellbore integrity and sand control.

If all of the previously mentioned prevention measures fail and a wellhead leak occurs, Canadian Natural will implement the following management measures to ensure containment and prevent or minimize environmental effects:

- Pressure transmitters installed on the flow line for each well will indicate a failure in the flow line if one has occurred. The operator will then be notified to take immediate action (outlined below).
- Isolation valves exist on the wellhead of each SAGD injection and production well. These valves will be used to contain the leak if the leak occurs downstream of a wellhead. The leak will be contained by simply shutting down the bottom hole pump and closing the wellhead valves.
- Steam injection will be shut in if a failure occurs upstream of the isolation valves and if the well is being circulated (warm-up). During the circulation phase, steam is injected and the return fluid is generally a combination of water and steam. The region near the wellbore is cold, so if steam injection is shut in, the area near the wellbore will quickly cool the wellbore fluid and condense the steam into water. Therefore, if steam injection is shut in, the wellbore would become a static column of

water. At a reservoir depth of 470 to 550 mTVD and operating pressure between 2,500 to 3,500 kPa, a column of water cannot flow to surface.

- The bottom hole pump will be immediately shut off if a failure occurs upstream of the isolation valves. Considering the reservoir depths and pressures associated with the Project, reservoir fluid would not be able to lift to surface without the use of a bottom hole pump during SAGD operation.
- Daily inspections of wellheads will ensure that minor leaks (not detected by the pressure transmitter) are detected during the operator rounds, which occur at least once every 12 hours.
- The Project will be staffed 24 hours/day. Canadian Natural's spill response plan (Volume 1, Section 8.4.3 of the December 2011 Application [Canadian Natural 2011]) outlines measures that Canadian Natural employees and contractors will take to prevent, correct and clean up leaks, accidental spills or releases. Project wellpads will be constructed with berms to contain runoff and any potential spills. Containment areas will be inspected regularly to avoid off-lease soil and/or water contamination in the event of a spill. In the event of a spill, Canadian Natural will promptly notify appropriate personnel and government agencies and a hazard assessment will be completed. Once the site is deemed safe to enter, Canadian Natural will rapidly clean up the spill and properly dispose of any contaminated materials.

c. As mentioned in the response to Round 1 SIR 148 and in the response to Round 2 SIR 24b, there is a low likelihood of a high-pressure release occurring. However, if the preventative measures identified above were to fail and a high-pressure release were to occur, it would immediately be identified through a change in pressure. The response time between identification of the issue and termination of flow is difficult to predict as there are several factors that may impact response time (e.g., weather conditions, location of closest operator); however Canadian Natural expects that flow could be terminated within 10 to 30 minutes of identification.

   If the leak is very minor and is not detected by a change in pressure in the flow line, then the leak would be identified visually during operator rounds. Minor leaks are expected to be detected in less than 12 hours by an operator. Once detected, the leak will be immediately assessed and appropriate action will be taken. If a termination of flow is required it will take place immediately as an operator will be at the wellhead site.

d. As mentioned in the response to Round 1 SIR 148 and in response to Round 2 SIR 24a, there is a low likelihood of a high-pressure release occurring. Leak volumes and distances are governed by a wide variety of parameters, pressures and assumptions. Any estimate on leak volumes and affected distance would therefore be completely speculative and cannot be generated with confidence.

References:

American Petroleum Institute. 2010. ANSI/API Spec 6A. *Specification for Wellhead and Christmas Tree Equipment, 20th Edition*. IS 10423:2009.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Submitted to Energy Resource Conservation Board and Alberta Environment and Water. December 2012.

Canadian Natural. 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

Enform. 2008. *Standards for Wellsite Supervision of Drilling, Completion and Workovers.* IRP Volume 7. Drilling and Completion Committee.

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25. Pages 343-344, SIR response 150

a. Response a: CNRL indicates it met with Fisheries and Oceans Canada (DFO) and it was agreed that culverts would be acceptable across watercourses that are not fish-bearing or that generally have habitat potential limited to only support forage species. While providing useful perspective on DFO's expectations of CNRL with regard to potential federal Fisheries Act Section 35 (2) habitat protection expectations, the response does not answer the question originally posed. The question requested a description of data collection to be undertaken to establish the watercourse or waterbody is not functioning as fish habitat. Data collection provided at the EIA level is insufficient to establish absence, as it is generally undertaken over the course of a single year. Given natural variability in the hydrological cycle, many watercourses in northern Alberta see episodic use by fish, including sportfish. Describe the data collection to be undertaken to empirically establish fish absence for sites where screens are to be installed to prevent blockage by beavers.

b. Response b: CNRL referred to their response to a, indicating that culverts are being proposed at crossing locations where fish passage would not be impeded. It is unclear from the documentation provided, how CNRL has established fish passage will not be impeded given the response to a. Further, the question requested CNRL discuss options, other than screens, which would not impede fish passage and which could be implemented in lieu of screens. This information is not provided in either a or b. Please provide the discussion.

c. Response c: CNRL was requested for a discussion of Canadian Natural's commitment to using alternative options [for management of beaver activity in relation to culverts] in areas where fish absence has not been established

empirically. While the use of open-bottom culverts and clear-span bridges is strongly encouraged, and CNRL's decision to use these methods is applauded, the question was asking specifically about the use of alternative methods other than screens to prevent culvert blockage in areas of beaver activity. Please provide this.

Response:

a. As discussed in response to Round 1 SIR 150a (Canadian Natural 2012), Canadian Natural will be installing culverts and possibly culvert screens at two fish-bearing watercourse crossings (i.e., KN001 and KN002, where only forage fish have been captured). These culverts will be designed, constructed and maintained to provide passage for all fish species present or potentially present.

   To date, it has not been necessary to mount screens (or "beaver guards") on culverts installed in the area for the approved Kirby South 2010 Project, as the degree of beaver activity in the vicinity of the culverts has not been significant enough to warrant them. It is possible that installation of screens on culverts may not be required for the Project. In the event that screen installation at KN001 and KN002 becomes necessary for the Project to prevent blockage due to beaver activity, the design used would be similar to what is shown in Figure 25-1. The typical design involves mesh size of approximately 15 cm by 15 cm so that fish passage upstream or downstream would not be impeded, including in the unlikely event that sportfish episodically utilize this habitat.

   Given that culverts and screens will be designed, constructed and maintained to allow for passage of all fish species present or potentially present, Canadian Natural does not believe additional fish absence/presence data collection at these sites is warranted.

b. As discussed in response to part a the culverts planned at KN001 and KN002 will be designed, constructed and maintained to provide passage for all fish species present or potentially present. Furthermore in the event that screens are required they will also be designed to allow passage for all fish species present or potentially present.

   If beaver activity threatens to block Project culverts, the only alternative to installation of screens that Canadian Natural is aware of is the removal of beavers via trapping, as described in the response to Round 1 SIR 197c, and removal of the dam in accordance with the *Water Act Code of Practice for Watercourse Crossings* (AENV 2007) and Fisheries and Oceans Canada *Alberta Operational Statement for Beaver Dam Removal* (DFO 2007). This approach would reduce the beaver activity in the area, thus reducing the potential for culvert blockage and effects on fish passage.

c. Canadian Natural is confident that screens, if required, will prevent culvert blockage by beavers while maintaining fish passage for all species present or potentially present. Therefore, a commitment to remove beavers and beaver dams as an alternative to screens is not warranted at this time.

REFERENCE
HTTP://WWW.CANADACULVERT.COM

PROJECT
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
PHOTO OF A BEAVER STOP® BEAVER GUARD POTENTIALLY UTILIZED FOR THE KIRBY EXPANSION PROJECT

Canadian Natural

PROJECT	12.1346.0014.5900		FILE No.	12134600145900A003
DESIGN	FD	20 Nov. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	21 Nov. 2012		
CHECK	MD	11 Dec. 2012	**FIGURE: 25-1**	
REVIEW	SM	11 Dec. 2012		

References:

AENV (Alberta Environment). 2007. *Guide to the Code of Practice for Watercourse Crossings, including Guidelines for Complying with the Codes of Practice.* Alberta Environment, May 2000, Revised April 2001. 29

Canadian Natural (Canadian Natural Resources Limited). 2012. Application for Approval of the Kirby In Situ Oil Sands Expansion Project. Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

DFO (Fisheries and Oceans Canada). 2007. *Alberta Operational Statement OS-EO03E – Beaver Dam Removal, Version 3.0*. Fisheries and Oceans Canada, 3 p.

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26. Page 344, SIR Response 151, Page 343, SIR Response 150, Page 361, SIR Response 162 c&d

a. Response a. CNRL indicates that culverts will be inspected annually. The response to SIR 150 indicates that CNRL will also use open-bottom culverts and clear-span bridges.

i. Will all road-watercourse crossings be inspected annually?

ii. If not, how frequently will crossings other than culverts be inspected?

iii. CNRL indicated in SIR Response 162 c, that inspections will be limited to visual inspection of culvert blockages from debris and scour around the inlet and outlet of the culvert and to ensure erosion control measures are working appropriately. Confirm that CNRL plans to implement inspection procedures outlined in the Manual – Alberta Roadway Watercourse Crossing Inspection Protocol for watercourse crossing inspections. (May 2012 Alberta Environment and Sustainable Resource Development).

b. Response b: The request asked CNRL to provide the planned timeline on remediation if issues are detected during road crossing inspections. CNRL responded that erosion or blockages will be remediated in a timely manner.

i. Define/describe what CNRL means by 'timely'.

ii. Provide a table, outlining standard crossing remediation issues, including, but not limited to erosion and blockages. Identify a target timeline for remediation to be undertaken or clearly describe the factors to be considered and provide

the timeframe (upper and lower bounds) within which road crossing issue will be remediated. Do not limit the discussion to culvert crossings.

Response:

a.

i. All road watercourse crossings will be inspected annually at a minimum.

ii. See the response to part ai.

iii. Canadian Natural confirms that inspection procedures outlined in the *Roadway Watercourse Crossing Inspection Manual* (Government of Alberta 2012) will be followed during the inspection of watercourse crossing structures.

b.

i. Issues at road watercourse crossings will be remediated as promptly as possible after they are identified with due consideration of factors such as the following:

- the urgency of correcting the issue (i.e., is emergency action required or can the issue be addressed through ongoing maintenance?);
- existence of restricted activity periods related to protection of the aquatic environment from activities in and around watercourses;
- the safety of the site for workers;
- suitability of site conditions for equipment access and construction activities (e.g., low watercourse flows or frozen to bottom, dry or frozen ground conditions);
- time required for design, fabrication and delivery of replacement crossing structures (if applicable); and
- timelines to obtain regulatory approvals and provide notifications (if applicable).

ii. Table 26-1 outlines road crossing remediation issues that could occur at Project watercourses crossings, target timeline for remediation if issues do occur, and the factors to be considered.

Table 26-1 Summary of Crossing Remediation Issues, Timelines, Factors to be Considered and Approaches

Watercourse Crossing Remediation Issue	Timeframe for Remediation	Approach to Remediation[a]	Factors to be Considered
Increased beaver activity in area (culvert)	One Month to a Year, timing will depend on urgency (i.e., degree of beaver activity) work site safety and delivery and installation of screens	• Install screen on culvert to prevent blockage (see the response to SIR 27(a))	• Refer to applicable DFO Operational Statements (DFO 2007d) • Refer to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007)
Beaver Damming (culvert)	For Dam Removal: Immediate (emergency only) to 14 to 30 days after providing notification to regulators and provided the site is safe for workers. For Screen Installation: May take one month to a year, timing will depend on work site safety, urgency (i.e., activity of beavers) and delivery and installation of screens	• Identify issue; determine if dam removal is required • Plan removal and inform regulatory authorities • Remove beaver dam • Install screen on culvert to prevent future blockage (see the response to SIR 27a))	• Beaver dams that block or reduce flow conveyance and potential fish passage at culvert waterway openings are a maintenance issue and may be a recurrent problem • Removal is subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Refer to applicable DFO Operational Statements (DFO 2007a,d)
Beaver damming (bridge)	Immediate (emergency only) to 14 to 30 days after providing notification to regulators and provided the site is safe for workers.	• Identify issue; determine if dam removal is required • Plan removal and inform regulatory authorities • Remove beaver dam • Remove beavers if damming becomes a frequent occurrence	• Beaver dams that block or reduce flow conveyance and potential fish passage at bridge or culvert waterway openings are a maintenance issue and may be a recurrent problem • Removal is subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Dam removal to be consistent with DFO Operational Statement (DFO 2007a), on watercourses where it applies • Coordination of beaver removal to be coordinated with the Registered Fur Management Area (trapline) holder, or with ESRD and an Aboriginal community registered trapper (see the response to round 1 SIR 197c))
Drift buildup (bridge or culvert)	Immediate (emergency only) to 14 to 30 days after providing notification to regulators and provided the site is safe for workers.	• Identify issue; determine if drift removal is required • Plan removal and inform regulatory authorities • Remove drift buildup	• Drift buildup that blocks or reduces flow conveyance and potential fish passage at bridge or culvert waterway openings is a maintenance issue and may result from high flow events • Removal is subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Drift removal to be consistent with DFO Operational Statements (DFO 2007b,d)
Heavy riparian vegetation growth (bridge or culvert)	Approximately 14 to 30 days after providing notification to regulators and provided the site is safe for workers.	• Identify issue; determine if riparian vegetation removal is required • Plan removal and inform regulatory authorities • Remove vegetation growth only to the extent required to address issue	• Riparian vegetation growth could potentially affect the integrity of the crossing structure, create safety concerns (.e.g., line of site blockage) or disrupt traffic movement and is a maintenance issue • Removal of riparian vegetation may include mowing, brushing, topping or slashing of terrestrial vegetation • Removal is subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Riparian vegetation removal to be consistent with DFO Operational Statement (DFO 2007e)
Ice buildup (culvert)	Immediate (emergency only) to 14 to 30 days after providing notification to regulators and provided the site is safe for workers.	• Identify issue; determine if ice removal is required • Plan removal and inform regulatory authorities • Remove ice buildup	• Ice buildup that blocks or reduces conveyance at culvert waterway openings is a maintenance issue and may be a recurring problem. Ice removal may be accomplished by steaming or physical removal upstream and downstream of the culvert • Removal is subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Ice removal to be consistent with DFO Operational Statements (DFO 2007b,d)
Channel changes including bed degradation or aggradation, bank or headslope erosion, lateral channel migration (bridge or culvert)	Emergency channel maintenance at the structure will be performed immediately, subject to regulatory requirements and site safety. Non-emergency channel maintenance may take anywhere from months (minor activity on small watercourse) to 1 year[b] for more complex activities or larger watercourses.	• Identify issue; determine if action is warranted due to existing or potential future instability threatening the structure • Develop remedial design • Inform and consult with regulatory authorities; obtain permits if required • Provide notification to regulators as required • Implement remediation as designed	• Remedial design should consider root cause of channel changes and incorporate mitigation, up to structure replacement • Remedial measures should be designed by a qualified professional; some measures may require the activity to extend away from the immediate proximity of the structure • Work subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007); alteration of a waterbody has specific mitigation and documentation requirements; may require additional *Water Act* and *Public Lands Act* permitting if outside the scope of the Code • Work not covered under Operational Statement; requires consultation and permitting with DFO
Outlet perching / end heaving (culvert)	Remediation may take anywhere from months (small culvert) to 1 year[b] for more complex situations.	• Identify issue; determine if action is warranted due to decrease in conveyance capacity or potential structural failure (inlet heaving) or fish passage impediment (perching) • Develop remedial design • Inform and consult with regulatory authorities; obtain permits if required • Provide notification to regulators as required • Implement remediation design	• Culvert inlets must be properly ballasted against uplift pressure, particularly for bridge-sized culverts • Remedial design should consider root cause of culvert inlet and outlet damage and incorporate mitigation, up to structure replacement • Remedial measures should be designed by a qualified professional • Work subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Work not covered under Operational Statement; requires consultation and permitting with DFO

Table 26-1 Summary of Crossing Remediation Issues, Timelines, Factors to be Considered and Approaches (continued)

Watercourse Crossing Remediation Issue	Timeframe for Remediation	Approach to Remediation[(a)]	Factors to be Considered
Structure Maintenance / Repair (bridge or culvert)	Emergency structure repair could be performed immediately, subject to regulatory requirements and site safety. Non-emergency repair or maintenance may take anywhere from months (small culvert or prefabricated bridge structure) to 1 year[(b)] for more complex structures and situations.	• Identify structure where maintenance or repair is required • Develop, or identify existing, maintenance plan • Inform and consult with regulatory authorities; obtain permits if required • Provide notification to regulators as required • Implement planned maintenance / repair	• Maintenance or repair of the bridge or culvert structure in part or in whole (e.g., maintenance or repair on bridge piers, abutments, superstructure; culvert barrel, headwalls, wingwalls) • Work subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • Refer to applicable DFO Operational Statements (DFO 2007b,d)
Structure Replacement (bridge or culvert)	Emergency replacement likely required for temporary bridge structures only (to provide immediate access to critical sites or to avoid long detours), and provided the site is safe for workers. Permanent bridge and culvert replacement may take anywhere from months (small culvert or prefabricated bridge structure) to 1 year[(b)] for more complex structures and situations.	• Identify structure where replacement is required • Develop design of new structure or identify standard design • Inform and consult with regulatory authorities; obtain permits if required • Provide notification to regulators as required • Implement as designed	• Bridge design and environmental work to be completed by qualified professionals • Emergency replacements may involve temporary crossings while a permanent solution is developed • Emergency and planned structure replacements may require temporary detour structures • Work subject to *Water Act* Code of Practice for Watercourse Crossings (AENV 2007) • May require consultation and permitting with DFO; clear-span structures covered under DFO Operational Statement (DFO 2007c)

(a) The *Water Act* Code of Practice for Watercourse Crossings includes a requirement to notify the Director at least 14 days prior to the activity. In emergency situations, this requirement is waived, but notification must be provided within 24 hours of the activity (AENV 2001). DFO Operational Statements (DFO 2007a, b, c, d, e) include a request that notification be provided at least 14 days prior to the activity, with immediate notification required in the event of emergencies.

(b) This estimate is based on planning, permitting, design and construction for resource road bridge or culvert crossings and considers potential construction delays due to Restricted Activity Periods.

References:

AENV (Alberta Environment). 2007. *Guide to the Code of Practice for Watercourse Crossings, including Guidelines for Complying with the Codes of Practice*. Alberta Environment, May 2000, Revised April 2001. 29 p.

AT (Alberta Transportation). 2008. *Bridge Inspection and Maintenance System, BIM Inspection Manual, Version 3.1*. Alberta Transportation, March 3, 2008.

DFO (Fisheries and Oceans Canada). 2007a. *Alberta Operational Statement OS-EO03E – Beaver Dam Removal, Version 3.0*. Fisheries and Oceans Canada, 3 p.

DFO. 2007b. *Alberta Operational Statement OS-EO04E – Bridge Maintenance, Version 3.0*. Fisheries and Oceans Canada, 3 p.

DFO. 2007c. *Alberta Operational Statement OS-EO05E – Clear-Span Bridges, Version 3.0*. Fisheries and Oceans Canada, 3 p.

DFO. 2007d. *Alberta Operational Statement OS-EO07E – Culvert Maintenance, Version 3.0*. Fisheries and Oceans Canada, 3 p.

DFO. 2007e. *Alberta Operational Statement OS-EO12E – Maintenance of Riparian Vegetation in Existing Rights-of-Way, Version 3.0*. Fisheries and Oceans Canada, 2 p.

Government of Alberta. 2012. *Roadway Watercourse Crossing Inspection Manual*. September 21, 2012.

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27. Page 346, SIR Response 153 c

CNRL indicates that *Thermal plumes are not expected to affect shallow surface waterbodies in the area of non-selected wellpads due to… the expected absence of shallow aquifers [and] the relatively shallow depth of surface waterbodies in the vicinity of non-selected well pads.*

a. Clarify the level of information available to characterize the presence/absence of shallow aquifers. Are there considerable gaps in the understanding of the shallow hydrogeology that encourage the use of qualifying language in these responses?

b. **It is interpreted from the use of the qualifier expected that the absence of these shallow aquifers has not been confirmed. Will the *expected absence of shallow aquifers* be confirmed for non-selected wells? If not, why not?**

Response:

a. Geological data collected for the Project was compiled and interpreted to develop a three-dimensional conceptual model of the hydrogeologic framework that became the foundation of the numerical hydrogeological model. Although various data sources were used to develop the conceptual model, the model was supported primarily by bitumen strat-hole petrophysical data. Although the Quaternary data coverage was considered extensive, the shallow petrophysical data was generally attenuated behind surface casings and therefore, not as well represented as the data sets for deeper aquifers. Nevertheless, it is believed that the shallow Quaternary environment was adequately characterized by existing data sources for the purpose of the EIA.

Canadian Natural does not believe there are considerable gaps in the understanding of the shallow hydrogeology. Shallow petrophysical data has not indicated the presence of continuous shallow aquifers and this has been confirmed at the Kirby South and Kirby North CPFs where shallow open-hole geophysical log data and/or borehole sample descriptions exists. Although open-hole geophysical log data and/or borehole sample descriptions are not available for shallow units outside the CPFs, continuous aquifers are not expected to exist in these shallow sediments as discussed below.

The accepted shallow surficial geological framework as discussed in the EIA for the part of the province encompassing the Project includes uppermost Grand Centre Formation tills commonly underlain by the Sand River Formation aquifer which is in turn underlain by the Marie Creek Formation. As discussed in detail in the response to Round 1 SIR 126 (Canadian Natural 2012), the Grand Centre Formation till forms the uppermost Quaternary unit across the majority of the LSA. The unit consists mainly of till and morainal material deposited during the last glacial advance into the area. The formation is divided into four clayey till members: Vilna, Kehiwin, Reita Lake and Hilda Lake (Andriashek 2003). Discontinuous sand and silt layers and lenses may exist within the Grand Centre Formation at the local scale. The uppermost portion of the Quaternary package is described as a complex environment of morainal, glaciofluvial, and eolian land forms (Andriashek 2003).

As discussed in the response to Round 1 SIR 126, detailed shallow stratigraphic information was obtained during geotechnical investigative work carried out at the Kirby South CPF in 2007 and, more recently, at the Kirby North CPF site. The data indicates that the shallow sedimentary package in these areas consists of poorly drained silty clay till with occasional fine to medium grained sand layers and lenses. Results of the investigation also indicate that the sand layers at both sites are discontinuous with variable depths and limited lateral extent and thickness. This is shown in north-south and east-west cross-sections which were generated from shallow borehole logs for holes drilled during the Kirby North CPF geotechnical investigation. The cross-sections are presented in the Round 1 SIR Figures 126-1 and 126-2 and the location map for the boreholes and the above cross-section is presented in Round 1 SIR Figure 126-3.

The findings of the geotechnical investigations are consistent with the accepted Quaternary geological framework for this part of the province. Therefore, although extensive shallow Quaternary data is not available for the entire Project Area, it is reasonable to expect that shallow continuous aquifers are not present in areas of the Project for which site-specific data are not available.

b. The implementation of the groundwater monitoring program will help confirm the absence of shallow aquifers. This program will include monitoring wells at selected pad sites to monitor thermal effects on local aquifers. The groundwater monitoring program will be developed in consultation with ESRD following Project approval and prior to Project start up.

In addition to the pad sites selected for long-term thermal monitoring, additional geological information will be collected from pad sites as part of the pad site geotechnical investigation programs. The objective of the pad site geotechnical investigations is to assess the subsoil and groundwater conditions so that necessary engineering properties can be determined. Geological data from geotechnical boreholes, which will be drilled to a maximum depth between 15 and 25 m, will be used to assess shallow Quaternary conditions at the sites and to investigate the presence or absence of shallow continuous aquifers. Sediments encountered during borehole drilling will be visually logged. The geological data recorded during borehole logging with be used to assess the stratigraphy of the shallow sedimentary units including identifying any potentially continuous aquifers beneath the pads. This may include the completion of stratigraphic cross-sections beneath pads and more regional cross-sections, linking pads in the event that regionally correlatable units are recognized.

References:

Andriashek, L.D. 2003. *Quaternary Geological Setting of the Athabasca Oil Sands (In Situ) Area Northeast Alberta*. EUB/AGSearth Science Report 2002-03. 2003. Alberta Energy Utilities Board.

Canadian Natural (Canadian Natural Resources Limited). 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

28. Page 348, SIR Response 154 b

CNRL indicates it is unaware of any design alternatives that could be considered in the construction phase that would facilitate the removal of well pads from deep peat. Given that altering wetlands to uplands will result in a reduction of wetland area on the landscape, and given regional cumulative loss of wetlands is a concern, particularly when the mineable oil sands area is included.

a. Is CNRL working or has CNRL considered working with other operators to develop and test design and construction alternatives to reduce costs and improve efficiency with respect to the removal of well pads from wetland areas?

Response:

a. As discussed in Volume 1, Section 11.11.2 of the December 2011 Application (Canadian Natural 2011) and in the response to Round 1 SIR 190 (Canadian Natural 2012), Canadian Natural, together with other operators, is partaking in wetlands reclamation research trials being conducted by the University of Alberta. Inherent in this work is the exchange of information regarding potential options for the construction of well pads in peatlands and their removal. Canadian Natural also regularly discusses and reviews new construction and reclamation alternatives through other formal and informal venues and forums, including meetings with service providers, trade shows, professional association meetings, educational seminars and conferences. For example, Canadian Natural attended the September 2012 Northern Alberta Institute of Technology Boreal Research Institute peatland restoration seminar and field tour held in Peace River. The seminar highlighted well pad reclamation research that is being conducted in the Peace River area, but also included information on alternate techniques for road construction in wetland areas. Canadian Natural considers each alternative for its applicability to Canadian Natural operations, potential effectiveness at each location, longevity and cost.

References:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project Application for Approval*. Submitted to Energy Resources Conservation Board and Alberta Environment and Water. December 2011. Calgary, AB.

Canadian Natural. 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

29. Page 350-351, SIR Response 156

a. Response a.

i. In the first sub-bullet in the response CNRL references the use of a geotextile-reinforced structure as an alternative to a clear-span bridge or an open-bottom culvert for watercourse crossings that are fish-bearing. Describe what is meant by a geotextile-reinforced structure. Provide photos and general design diagrams.

ii. CNRL was requested to clarify whether watercourse crossings that might involve a culvert will be installed on watercourses with a defined channel. In response, CNRL identifies that clear-span bridges would be used in watercourses with complex fish communities, and on the main channel in a watercourse that has more than one channel. In the third bullet, CNRL describes conversations held with DFO in support of CNRL's requirements under the federal Fisheries Act, and indicates that for watercourses that are not fish-bearing or generally …only support forage species, it was agreed that a standard culvert crossing would be acceptable without requiring a federal Fisheries Act authorization, While providing useful perspective on DFO's expectations of CNRL with regard to potential federal Fisheries Act Section 35 (2) habitat protection expectations, the response does not answer the question originally posed. Nowhere does CNRL clearly state whether a culvert would be installed on a watercourse with a defined channel, nor is it identified how CNRL will determine the watercourse is not-fish-bearing or limited to a forage fish community. ESRD has a mandate to manage fisheries in the province and as such, needs to understand the likely impacts of aquatic fragmentation. Culvert installation on fish-bearing waters, including those limited to episodic use or a small-bodied forage fish community still have the potential to fragment the aquatic habitat and reduce productivity. Were ESRD fish management staff consulted with respect to CNRL's decision to use culverts on fish-bearing streams? If so, were they in agreement with the decision? If not, did they provide advice to CNRL on limiting fragmentation potential? If so, please describe.

iii. Confirm that CNRL plans to design any culvert crossings to be constructed in fish-bearing streams to provide fish passage for all species present or potentially present.

b. Response b. CNRL states, *Well-designed culvert crossings have been demonstrated to perform well over a long period of time for road crossings.*

i. Clarify what is meant by *perform well*. Clearly identify the criteria considered in the assessment of a *well-performing* crossing.

ii. Clarify what is meant by *long time.* How does this compare to the length of time CNRL's road crossings will be in use?

iii. From an ecological perspective, this statement is not well-supported in the primary literature. Provide supporting documentation that confirms the conclusion in the context of the watershed characteristics, culvert design proposed, crossing lifespan, and culvert performance criteria with respect to aquatic fragmentation and fish passage.

Response:

a.

i. After further Project planning, Canadian Natural will not be considering geotextile-reinforced structures as a potential alternative for watercourse crossings.

ii. Consultation with ESRD fisheries management staff is occurring through the Project Application and EIA review process. The perspectives of ESRD staff with respect to Canadian Natural's plans to use culverts on fish-bearing streams is available in the SIRs prepared by ESRD. Prior to construction of watercourses crossings, consultation with ESRD will also occur during the regulatory review of Canadian Natural's applications for the required Project surface dispositions (e.g., roads). It is Canadian Natural's understanding that ESRD refers applications involving watercourses crossings to the provincial fisheries management staff in the local ESRD field office.

iii. Canadian Natural is committed to designing, constructing and maintaining culvert crossings on fish-bearing watercourses to provide passage for all fish species present or potentially present. Additional details are provided in the responses to Round 2 SIR 25 and SIR 26.

b.

i. A culvert watercourse crossing is considered to "perform well" if it meets the following two criteria: (1) will convey watercourse flows, and (2) will allow fish passage in the case of fish-bearing watercourses (i.e., watercourse crossings KN001 and KN002). Canadian Natural will design and construct culvert watercourse crossings to perform well by following regulatory directives and guidelines, including the *Code of Practice for Watercourse Crossings* (AENV 2007) and the *Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta* (Alberta Transportation 2001). Ongoing culvert performance will be addressed by Canadian Natural through the culvert monitoring and maintenance program described in the response to Round 2 SIR 26. This approach has resulted in culverts that perform well, as defined above, at Canadian Natural's PAW project.

ii. "Long Time" is defined by Canadian Natural as the period of time the road crossing of the watercourse will be in use (e.g., at a minimum, the 10 year life of a well pad).

Canadian Natural designs and constructs culverts with the intent of meeting this period of time. However, during this time, issues may arise with the culvert crossing that affect the performance of the culvert. As discussed in the response to part bi, ongoing culvert performance will be addressed by Canadian Natural through the culvert monitoring and maintenance program described in the response to Round 2 SIR 26.

iii. It has been Canadian Natural's experience (e.g., at the PAW project) that implementing appropriate design and construction methods and an appropriate monitoring and maintenance program will result in culverts that perform well. Canadian Natural will meet regulatory directives and guidelines (response to part bi) and will incorporate past industry experience when designing and constructing culvert crossings. Ongoing culvert performance will be addressed by Canadian Natural through the culvert monitoring and maintenance program described in the response to Round 2 SIR 26. As a result, impacts to fish passage and aquatic habitat fragmentation from the Project are not expected.

References:

AENV (Alberta Environment). 2007. *Code of Practice for Watercourse Crossings. Water Act* – Water (Ministerial) Regulation. Alberta Queen's Printer. February 2007. Edmonton, AB. 26 pp.

Alberta Transportation. 2001. *Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta*. October, 2001 (revised August 2009). Government of Alberta.

30. Page 357-358, SIR Response 160 and Page 153, SIR Response 60

The issue this question was intended to focus on is the likelihood of increased fish management challenges associated with the growing regional and local population. In an effort to better describe the gap in the assessment, consider: in addition to CNRL's staff, timber will be salvaged by local and regional forest companies, aggregate will be sourced from local aggregate operations and it is assumed that CNRL will employ the staff of other local and regional service providers as part of the construction and operation of the project. Locally and regionally-based staff, service providers (includes grocers, fuel station staff, hospital staff, government employees, etc) and their families will require services to live and work in the area. All of these factors will contribute to an expanded population, a proportional increase in anglers, and consequently, an increase in angling pressure. CNRL indicates the Government of Alberta will *manage the fisheries resources accordingly*. Although it is ESRD's role to manage fisheries, the cumulative population increase as a result of expanded

industrial activity in the area may overwhelm the utility of the tools available to manage finite fisheries resources. In order for ESRD to assess this and, ideally plan for it, adequate information on the potential impact is needed, similar to the need to have air quality modeling. Provide an assessment of regional angling pressure increases. For guidance consider the following:

a. **The current proportion of the regional population engaged in angling. (Note: provincially reported proportion is 9% - does the subject area compare?).**

b. **The frequency with which regional anglers fish.**

c. **Where regional anglers fish.**

d. **The preferred target species.**

e. **Expected catch rates.**

f. **Based on the expected regional population, extrapolate / characterize expected increased regional fishing pressure. Support the assessment with references.**

Response:

Volume 6, Section 5, Table 5.6.2 of the December 2011 Application (Canadian Natural 2011) provides the estimated incremental direct, indirect and induced population change for the RSA due to the Project for the years 2014 to 2025. Based on the assumption noted in part a, that 9% of this new population would engage in fishing, the incremental increase in the number of anglers in the region would range from 25 to 37 people per year. The 9% provincial proportion is considered to be a conservative estimate, when compared to an estimated 4.7% of the regional population actively engaged in fishing in the Zone 4 Northern Boreal (NB4) Fish Management Unit in 2010 The 4.7% was derived using the population of the Regional Municipality of Wood Buffalo and the number of anglers in NB4 (ASRD 2012).

There are 4,858 regional anglers (licensed and unlicensed) living in the NB4 Fish Management Unit of the Northern Boreal Zone (derived from ASRD 2012), which includes the Regional Municipality of Wood Buffalo and the northern portion of the proposed Project Area. The southern portion of the proposed Project Area overlaps a portion of the Zone 1 Northern Boreal (NB1) Fish Management Unit. There were 14,581 anglers living in NB1 in 2010 (ASRD 2012). Therefore, using the 9%, the addition of 25 to 37 anglers due to the Project between 2014 and 2025 may increase the number of regional anglers by between 0.5% and 0.7% per year in NB4, and by between 0.1% and 0.3% per year in NB1. This change is considered small given the size of the NB4 and NB1 Fish Management Units (71,495 km^2 and 40,895 km^2 respectively); and when considered in combination with Canadian Natural's commitment to prohibit workers from fishing while residing in camp, results in the conclusion that the Project is expected to have a negligible effect on regional angling pressures. Based on this result, and in keeping with the EIA methods described in Volume 3, Section 1.5, the effects of future population increases due to other planned developments in the region (i.e., the PDC) do not require further assessment.

References:

ASRD (Alberta Sustainable Resource Development). 2012. *Sport Fishing in Alberta 2010.* Summary Report from the Eight Survey of Recreational Fishing in Canada. Government of Alberta, Fisheries Management Branch, Alberta Sustainable Resource Development. March 2012.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Volumes 1 to 6. Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

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31. Page 365, SIR Response 164 b

CNRL was requested for a discussion of the potential influence a thermal plume might have on aquatic biota should a thermal plume reach a surface waterbody [or watercourse]. CNRL was to include but not limit the discussion to interstitial biota and primary producers and to discuss both temperature effects and the associated constituent mobilization.

This discussion was not provided. Please provide it.

Response:

Thermally Liberated Associated Constituents

Steam injection at thermal in situ oil sands operations in northeastern Alberta has been observed to increase groundwater temperature and affect the solubility of minerals in Tertiary and Quaternary aged formations. This has been noted by Fennell (2008) in his research into the effects of aquifer heating on groundwater chemistry at the Imperial Oil Cold Lake In-Situ Project. Groundwater samples taken from monitoring wells installed as part of Fennell's field experiment were analyzed for the following parameters:

- field-measured parameters including temperature, pH, electrical conductivity, redox;
- routine parameters including major ions (Ca, Mg, Na, K, HCO_3, SO_4, Cl), secondary and trace elements, alkalinity, hardness, EC and total dissolved solids (TDS);
- dissolved organic carbon (DOC);

- total phenols;
- total and dissolved metals; and
- trace elements.

Results of Fennell's field test indicated a change in groundwater quality as a result of aquifer heating. Fennell identified increasing concentrations in several major ions (Ca, Mg, Na, K, HCO_3, SO_4, Cl). Certain other secondary and trace elements (As, Ba, B, Mo, P, Si, Sr) exhibited small to moderate increases in aqueous concentration with rising groundwater temperature. In contrast, parameters that exhibited a decreasing trend during aquifer heating included pH, redox, iron and manganese. It is not clear in Fennell's work whether the concentrations of any of these constituents exceeded either of the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) or the *Canadian Council of Ministers of the Environment* (CCME) *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.

At Canadian Natural's PAW project located near Cold Lake Alberta, Canadian Natural has been investigating the mobility of dissolved arsenic in groundwater due to thermal operations at Z8 Pad. An update to the investigation was presented in the Primrose East Expansion Project Application (Canadian Natural 2006). The investigation found that dissolved arsenic concentrations in groundwater increased in association with elevated groundwater temperatures associated with thermal well steaming (Canadian Natural 2006). In addition to dissolved arsenic the investigation also involved the analyses of groundwater for major ions, total and dissolved metals and trace elements. Analytical results indicated that the heating of groundwater did not result in the mobilization of any constituents in excess of the GCDWQ or the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* guidelines other than arsenic which was noted to exceed at background concentrations (Canadian Natural 2006; CCME 1999; Health Canada 2012).

Review of Arsenic Toxicity on Aquatic Organisms

Due to recognized thermal mobilization of arsenic, a literature review of the toxicity of arsenic on aquatic organisms in fresh water was conducted. This review is summarized in Table 31-1.

Table 31-1 Review of Effects Data on Aquatic Organisms

Species	NOEC [µg/L]	LOEC [µg/L]	MATC [µg/L]	EC50/LC50 [µg/L]
Algae				
Scenedesmus obliquus	-	-	-	50
Chlorella vulgaris	30	60	-	-
Pelagic Invertebrates				
Daphnia magna	-	3,400 to 10,000	630 to 1,320	-
Benthic Invertebrates				
Hyalella azteca	-	-	-	293 to 618
Gammarus pseudolimnaeus	-	-	88 to 970[(a)]	
Fish				
Pink salmon	2,650 to 9,500	-	-	-
Pimephales promelas	530	1,500	-	25,600
Rainbow trout	-	-	-	20,200

(a) LC20.

- = not applicable.

The review is based on a consideration of:

- the behaviour of arsenic in freshwater systems, including those factors that can directly affect the toxicity of arsenic to freshwater organisms, since groundwater discharging to surface waters is expected to undergo complexation reactions with naturally occurring constituents;
- the mechanisms of exposure of aquatic life; and
- a review of the toxicity data available from various sources, including compiled databases, and the scientific literature that provide levels of effect of a range of organisms.

The toxicity test data provided in Table 31-1 is considered with respect to the lowest concentrations reported for each of the major effects endpoints:

- **NOECs – No Observed Effect Concentrations** are statistically derived endpoints that denote the concentration at which no observed adverse effect was noted upon the test organism. These are typically measured over longer time periods (usually 28-day exposures), and are considered as safe concentrations for chronic or long term exposure.
- **LOECs – Lowest Observed Effect Concentrations** are statistically derived endpoints, also based on long-term exposures which denote the lowest concentration at which a measurable response was observed in the test organism. The effect measured depends on the endpoint tested. Typically these fall into three categories:
  - growth is a sublethal endpoint that denotes the exposure concentration at which measureable changes in growth were observed;

   - reproduction is also a sublethal endpoint that denotes the concentration at which changes in reproductive success were observed; and
   - survival is a lethal endpoint that denotes the lowest concentration at which mortality of a defined fraction of the test population was observed.
- **MATC – Maximum Acceptable Toxicant Concentration** calculated as the geometric mean of the NOEC and LOEC.
- **LC50 – Lethal Concentration 50** denotes the concentration at which 50% of the test organisms suffered mortality. These are typically measured over short time periods of 1-4 days, and indicate the concentration at which significant adverse effects would be predicted on the test species.
- **EC50 - Half Maximal Effective Concentration** refers to the concentration that induces a response halfway between the baseline and the mortality level after some specified exposure time.

The data in Table 31-1 indicate that algal species are likely to be the most sensitive to the effects of arsenic. Effects levels in freshwater environments are expected to occur at concentrations above 50 µg/L. Effects on invertebrates typically occur at much higher concentrations. Sensitive benthic species such as amphipods could be affected at concentrations above 970 µg/L. While the MATC for arsenite is reported as 88 µg/L, as noted in the response to Round 2 SIR Response 22, the prevalence of arsenite in natural waters is low, and therefore the effect level for benthic invertebrates is based on the MATC for arsenate of 970 µg/L.

Fish appear to be the least sensitive to arsenic. Concentrations above 1,500 µg/L have potential to result in adverse effects on some sensitive species under long-term exposure. Short-term exposures, as denoted by the LC50s for the fish species reviewed, are much higher.

The concentrations presented in Table 31-1 are based on fully mixed conditions in the water column of the receiving waterbody. Laboratory tests have a number of limitations that can result in over-estimating the effects of arsenic in natural waters. Therefore, the values should be considered as conservative estimates of toxicity thresholds for the species listed. It is expected that actual toxicity thresholds may be higher, particularly in environments where the presence of dissolved or particulate organic matter in the water column can affect arsenic bioavailability.

Based on Canadian Natural's understanding of the near-surface aquifer occurrences, the conditions in the Project Area that could result in the delivery of dissolved arsenic at the concentrations discussed above to the aquatic environment exist only in limited areas. In most places, groundwater pathways between pads and water features are not expected to exist. Additionally, relatively high concentrations of oxygen in shallower aquifers are expected to encourage the partitioning of dissolved arsenic to aquifer solids, serving to hinder arsenic plume migration.

As discussed in the response to Round 2 SIR 22b, Canadian Natural will be assessing the potential for thermal and dissolved arsenic migration in areas where a hydraulic connection to surface water features may exist. These areas include possible migration of thermal plumes from well pads KN-07, KN-20 and KN-35 toward water features (e.g., Edwards Lake) in the area. Provided below is a discussion of the potential effects of elevated temperature from thermal plumes on aquatic organisms in Edwards Lake.

The Effects of Elevated Temperature on Aquatic Organisms

Seasonal temperature profiles in Edwards Lake were measured in 2008 as part of the baseline study for the Enerplus Kirby Oil Sands Phase 1 Project (Enermark 2008). Lake temperatures vary from a high of 20°C in summer to values of 1°C in the winter. The warm summer temperatures extend to a depth of greater than 4 m. Near-surface seepage into the lake is estimated to be at a temperature of 3°C to 4°C based on the limited data set of near surface groundwater temperature, although shallow groundwater samples have indicated summer temperatures of 7°C to 8°C.

Maximum groundwater temperatures near Edwards Lake due to steaming activities will be a function of the seepage velocity and the aquifer thickness. In the case of Z8 Pad, Canadian Natural (2006) reported an approximate 5°C temperature increase at a well completed in a 6-m-thick Empress Formation aquifer located 260 m downgradient of the Z8 Pad which had been operating (cyclic steam stimulation) for approximately 15 years. Although it is difficult to accurately predict the future temperature of groundwater at the shore of Edwards Lake, the experience at Canadian Natural's Z8 Pad indicates there could be a groundwater temperature increase of up to 5°C at some point in time from the localized thermal plume from well pad KN-07 if a pathway from the pad does in fact exist.

Groundwater from a thermal plume discharging into Edwards Lake would represent only a portion of total groundwater discharge into the lake. Given the substantially larger volume of water in the lake relative to groundwater inflow volumes at elevated temperatures, it is very likely that there will be a negligible magnitude effect on the lake water temperatures from any discharging thermal plume groundwater.

Increased temperatures in the lake sediments caused by a warmer groundwater plume may have a stimulating effect on sediment microorganisms, and potentially primary producers (phytoplankton) in the water column. During the open-water season, planktonic primary production is more likely controlled by light availability and aquatic macrophyte growth than water temperature, because Edwards Lake is a brown-water lake with abundant macrophyte growth. In addition, during this season, the temperature of the groundwater plume is within the typical range of variation in lake water. This suggests that a measurable change in aquatic communities is unlikely during open-water conditions. During winter, phytoplankton growth is negligible under ice and the potential effect of elevated groundwater temperature, assuming it is insufficient to keep part of the lake ice-free, could be an enhancement of microbial growth in bottom sediments. This could result in an increase of sediment oxygen demand, potentially reducing under-ice dissolved oxygen concentration. However, as noted above, the large volume of lake water and natural groundwater discharge relative to heated groundwater inflow volume suggests that temperature increases in Edwards Lake will likely be negligible, with a corresponding negligible effect on aquatic communities.

Migration pathways, which would allow thermal plumes to interact with water features within the Project Area, are expected to be limited in the area. Even with the existence of a pathway, the loss of heat to the bounding aquitard may serve to hinder thermal plume migration in the relatively shallow Sand River Formation aquifer.

As discussed above and in response to Round 2 SIR 24b Canadian Natural will be assessing the potential for thermal and dissolved arsenic migration in areas where a hydraulic connection to surface water features may exist. These areas include possible migration of thermal plumes from well pads KN-07, KN-20 and KN-35 toward water features in the area.

References:

CCME (Canadian Council of Ministers of the Environment). 1999 and updates. *Canadian Water Quality Guidelines for the Protection of Aquatic Life - Summary Table*. Available at: http://ceqg-rcqe.ccme.ca/. Accessed November 2012.

Canadian Natural (Canadian Natural Resources Limited). 2006. *Primrose In Situ Oil Sands Project, Primrose East Expansion, Application for Approval. Volume 4: Aquatic Resources, Appendix II Hydrogeology Baseline Report*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. January 2006.

Enermark (Enermark Inc.). 2008. *Application for Approval of the Enerplus Resources Fund Kirby Oil Sands Project Phase 1*. Submitted to Alberta Environment and the Energy Resources Conservation Board. September 2008.

Fennell, J.W. 2008. *Effects of Aquifer Heating on Groundwater Chemistry with a Review of Arsenic and its Mobility*. Doctoral dissertation. University of Calgary. March 2008.

Health Canada. 2012. *Guidelines for Canadian Drinking Water Quality – Summary Table.* Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment. Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum_guide-res_recom/index-eng.php. Accessed November 2012.

32. Page 365-372, SIR response 165 b

Based on the maps provided, CNRL is planning to access bitumen located below Edwards Lake, Unnamed Lake 1, Waterbody 3, Waterbody 3, and Unnamed Lake 8. Site-specific fish habitat characteristics as requested were not provided. For example, CNRL simply states that Edwards Lake provides moderate habitat use potential, year-round for northern pike, sucker species, and forage fish species, and that northern pike have been captured in the lake. However, CNRL plans to access resource under the northeast half of the lake. To help guide the responses, consider for the Edwards Lake example:

- **specific habitat attributes present in the northeast half of the lake that might be influenced by surface heave.**
- **is there spawning habitat in the northeast section of the lake?**
- **If so, what is its current depth, and likely range of depths through time?**
- **Will surface heave potentially reduce the depths/areas of this spawning habitat and reduce its utility?**

a. Using a similar logical approach, characterize the site–specific fish habitat characteristics for those watercourses or waterbodies under which surface heave may occur.

b. Describe how CNRL will monitor depth and surface area of these waterbodies in conjunction with surface heave to confirm conclusions that there will be no impacts to fish and fish habitat in these waterbodies. Clearly describe methods, periodicity and reporting of this monitoring.

Response:

a. As discussed in response to Round 2 SIR 20, given that Canadian Natural is predicting, with a high level of confidence, that the environmental consequence of surface heave will be negligible, Canadian Natural is also very confident that changes to fish habitat characteristics as a result of surface heave is not predicted to occur at waterbodies or watercourses in the Project Area.

General habitat characteristics are documented for watercourses and waterbodies including water depth, water quality parameters, fish species present and presence of habitat types. In general, potential northern pike spawning habitat conditions are found within select watercourses and waterbodies throughout the Project Area but access by northern pike to these watercourses and waterbodies may not be possible due to beaver activity, poor connectivity, or insufficient migratory routes. Watercourses and waterbodies in the Project Area contain sections of shallow water with abundant vegetation which is ideal for northern pike spawning habitat. Northern pike are the most likely species potentially impacted by potential heave due to their spawning habitat requirements. Potential spawning habitat is limited for other sport fish species that provide recreational fishing opportunities.

Fish habitat characteristics for the watercourses and waterbodies under which surface heave would occur is provided within the baseline reports including the Aquatic Ecology Baseline Report (provided on CD with the December 2011 Application [Canadian Natural 2011], Watercourse Crossing Report (Canadian Natural 2011), and the Enerplus Kirby Oil Sands Project Phase 1 (Enermark 2008) and Kirby In Situ Oil Sands Project (Canadian Natural 2007) project baselines. Below is a list of watercourse and waterbody sites identified in Round 1 SIR Figures 165-1 and 165-2, under which surface heave may occur. The appropriate source of the habitat information is identified for each waterbody and watercourse.

- Edwards Lake (Enermark 2008);
- Unnamed Lake 1 (Canadian Natural 2007);
- Waterbody 1 - Aquatic Ecology Baseline Report (Canadian Natural 2011);
- Waterbody 3 – Aquatic Ecology Baseline Report (Canadian Natural 2011);
- Unnamed Lake 8 (Canadian Natural 2007);
- Sunday Creek – Kirby North 2008 (Enermark 2008);
- Watercourse 13 (Inlet of Glover Lake) (Enermark 2008);
- Tributary 1 (Inlet to Unnamed Lake 1 (Canadian Natural 2007);
- Tributary 5 (Canadian Natural 2007);
- KN001 Watercourse - Watercourse Crossing Report (Canadian Natural 2011);
- KN002 Watercourse - Watercourse Crossing Report (Canadian Natural 2011);
- KN004 Watercourse – Watercourse Crossing Report (Canadian Natural 2011);
- KN007 Watercourse - Watercourse Crossing Report (Canadian Natural 2011); and
- Watercourse SCT-3 - Aquatic Ecology Baseline Report (Canadian Natural 2011).

None of the habitat in the Project Area was identified as critical or unique. The effects of potential heave on this habitat are predicted to be negligible, and thus will not reduce the utility of this habitat. Canadian Natural does not believe that collecting additional fish habitat data for the purpose of determining potential impacts as a result of heave is therefore warranted.

b. Given Canadian Natural's high level of confidence in the predicted negligible environmental consequence related to ground heave (see Round 2 SIR 20) Canadian

Natural does not believe that heave monitoring or depth and surface area monitoring at the watercourse or waterbodies identified in part a is warranted.

References:

Canadian Natural (Canadian Natural Resources Limited). 2007. *Kirby In-Situ Oil Sands Project Application for Approval*. Volumes 1-6. Submitted to Energy Resources Conservation Board and Alberta Environment. September 2007. Calgary, AB.

Canadian Natural. 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Volumes 1 to 6. Submitted to Alberta Environment and Water, and the Energy Resources Conservation Board. December 2011.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Enermark (Enermark Inc.). 2008. *Application for Approval of the Enerplus Resources Fund Kirby Oil Sands Project Phase 1*. Submitted to Alberta Environment and the Energy Resources Conservation Board. September 2008.

33. Page 373, SIR Response 166

Given no field assessment of spring freshet, migration and spawning use was undertaken:

a. Discuss the implications to conclusions presented with particular reference to watercourse crossing sites and conclusions that fish are absent or limited to the forage fish community.

Further, given the timing, methodology, and multi-annual and areal extent of field investigations

b. Discuss the likelihood that episodic use and presence or rare or elusive species (e.g., sculpins) was underestimated.

Response:

a. As indicated in the response to Round 1 SIR 166 (Canadian Natural 2012), the following spring freshet, migration and spawning use surveys were undertaken in previous assessments and were considered in the Aquatic Ecology Assessment (Volume 4, Section 4 of the December 2011 Application [Canadian Natural 2011]):

- Canadian Natural 2007;
- Devon 2003;
- EnCana 2008; and
- Enermark 2008.

The seasonal sampling efforts within the previous assessments are provided in the Aquatic Ecology Baseline Report Section 3.1.1 provided on CD with the December 2011 Application (Canadian Natural 2011) and are summarized in Table 33-1. This information was reviewed for data gaps prior to the planning of the Project field program. Based on the review it was determined that the available spring freshet, migration and spawning data were appropriate for the completion of the aquatic assessment and further collection of spring data was not required. As part of the Project fieldwork, fish habitat assessments were completed and included determination of habitat suitability for spawning and migration. In consideration of the available data and the additional fieldwork completed for the Project (Table 33-1), Canadian Natural is confident that there are no implications to the conclusions presented in the EIA.

Table 33-1 Summary of Seasonal Sampling Efforts Completed for Previous Assessments and the 2011 Surveys Completed for the Kirby Expansion Project

Project	Site	Fish and Fish Habitat Sampling Period			
		Spring	Summer	Fall	Winter
Enerplus Kirby Oil Sands Project Phase 1 (Enermark 2008)	Edwards Lake	●	●	●	●
	Glover Lake	●	●	●	●
	WB-7	●	●		●
	WB-21	●	●	●	●
	WB-22	●	●	●	●
	Birch Creek	●	●	●	●
	Sunday Creek	●	●	●	●
	WC-11	●	●		●
	WC-12	●	●		
	WC-13	●	●	●	●

Table 33-1 Summary of Seasonal Sampling Efforts Completed for Previous Assessments and the 2011 Surveys Completed for the Kirby Expansion Project (continued)

Project	Site	Fish and Fish Habitat Sampling Period			
		Spring	Summer	Fall	Winter
Canadian Natural In Situ Oil Sands Project (RAX 2002; Canadian Natural 2007)	Waiu Lake	●	●	●	●
	Ipiatik Lake				●
	Unnamed Lake 1	●	●	●	●
	Unnamed Lake 2		●		●
	Unnamed Lake 3	●	●	●	●
	Unnamed Lake 4	●	●	●	●
	Unnamed Lake 5		●		●
	Unnamed Lake 6				●
	Unnamed Lake 7	●	●	●	
	Unnamed Lake 8				●
	Unnamed Lake 11				●
	Unnamed Lake 12		●		●
	Unnamed Lake 13		●		●
	Trib 5 - Reach 1	●	●		●
	Trib 5 - Reach 2	●	●	●	●
	Trib 5 - Reach 4	●	●	●	●
	Trib 1	●	●		●
	Trib 2	●	●		●
	Trib 3	●	●		●
	Trib 4	●	●	●	●
EnCana (2008)	Christina Lake	●	●	●	
	Unnamed Waterbody 1	●	●	●	●
	Unnamed Waterbody 2	●	●	●	●
	Unnamed Waterbody 3	●	●	●	●
	Unnamed Waterbody 4	●	●	●	●
	Unnamed Waterbody 5	●	●	●	●
	Unnamed Waterbody 6	●	●	●	●
	Sunday Creek	●	●	●	●
	Unnamed Tributary 1	●	●	●	●
	Unnamed Tributary 2	●	●	●	●
	Unnamed Tributary 3	●	●	●	●
	Unnamed Tributary 4	●	●	●	●
	Unnamed Tributary 5				●
Devon (2003)	Unnamed Pond 1	●			
	Unnamed Pond 2	●			
	Hay Lake				●
	Sunday Creek	●			
	Unnamed Creek (Monday Creek)	●			
	Hay Creek				●

Table 33-1 Summary of Seasonal Sampling Efforts Completed for Previous Assessments and the 2011 Surveys Completed for the Kirby Expansion Project (continued)

Project	Site	Fish and Fish Habitat Sampling Period			
		Spring	Summer	Fall	Winter
Kirby Expansion Project (Aquatic Ecology Baseline Report, Canadian Natural 2011)	Wiau Lake		●		●
	Unnamed Waterbody 1		●		●
	Unnamed Waterbody -2		●		●
	Unnamed Waterbody 3		●		
	Unnamed Waterbody 4		●		
	WLT-1		●		
	WLT-2		●		
	SCT-1		●		
	SCT-2		●		
	SCT-3		●		
	UNT-1		●		
Kirby Expansion Project (Watercourse Crossing Report, Canadian Natural 2011)	KN001 (unnamed tributary of Sunday Creek)		●		
	KN002 (Sunday Creek)		●		
	KN003 (unnamed tributary of Sunday Creek)		●		
	KN004 (no defined channel)		●		
	KN005 (no defined channel)		●		
	KN006 (unnamed tributary of Wiau Lake)		●		
	KN007 (unnamed tributary of Birch Creek)		●		
	KN008 (no defined channel)		●		
	KS003 (unnamed tributary of Wiau Lake)		●		
	KS004 (unnamed tributary of Winefred Lake)		●		
	KS005 (unnamed tributary of Winefred Lake)		●		
	KS006 (unnamed tributary of Winefred Lake)		●		
	KS007 (no defined channel)		●		

With particular reference to watercourse crossing sites, the data collection at each of the crossing locations document fish presence, multiple habitat parameters and connectivity to adjacent habitat. If the habitat parameters indicate nil potential habitat or there are severe limitations to fish access then a determination of fish absence is appropriate. The crossing locations where no fish or only a forage fish community was identified are typically in headwater areas of the watersheds. These watercourses either lack sufficient downstream connectivity or have been heavily impacted by beaver activity in downstream sections, severely limiting seasonal spawning or migratory access in the spring. In addition, the crossing sites are characterized by low flow, muskeg type habitat and it is unlikely that obstacles to fish access will be removed naturally. Canadian Natural is confident the conclusions presented regarding fish absence or limited forage fish communities are valid.

Furthermore as discussed in the responses to Round 2 SIRs 25 and 29 Canadian Natural is committed to designing, constructing and maintaining culvert crossings on fish-bearing watercourses to provide passage for all fish species present or potentially present.

Due to the large amount of existing information regarding fish and fish habitat in the LSA (as described in Table 33-1 and the Aquatic Ecology Baseline Report), the likelihood is low that episodic use and presence of rare or elusive species (e.g., sculpins) are underestimated. The presence and known distribution of rare or elusive species has been well documented in the watercourses and waterbodies within the LSA and this information was considered in the assessment. Based on the existing information, the overall likelihood of rare and elusive species being present or using the area is limited by access. Access to the watercourses and waterbodies is restricted by poor connectivity of channels through muskeg areas and obstructions due to extensive beaver activity. The overall likelihood of rare and elusive species being present or using the area, even episodically, is also limited by poor habitat suitability in the LSA. For example, with respect to slimy sculpin, they were identified at Site SCT-1, which contained their preferred cobble and gravel substrate that provides rocky cover. However, this type of habitat was limited within the watercourses and waterbodies located in the LSA.

References:

Canadian Natural (Canadian Natural Resources Limited). 2007. *Kirby In-Situ Oil Sands Project Application for Approval*. Volumes 1-6. Submitted to Energy Resources Conservation Board and Alberta Environment. September 2007. Calgary, AB.

Canadian Natural. 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Volumes 1 to 6. Submitted to Alberta Environment and Water, and the Energy Resources Conservation Board. December 2011.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Devon (Devon Canada Corporation). 2003. *Application for Approval for the Devon Jackfish Project*. Volume 2 – Environmental Impact Assessment. Submitted to Alberta Energy and Utilities Board and Alberta Environment. November 2003. Calgary, Alberta.

EnCana (EnCana FCCL Ltd.). 2008. *Fish and Fish Habitat Baseline Report for EnCana Christina Lake Thermal Expansion Project, Phase E, F and G*. Submitted to EnCana FCCL Oils Sands Ltd. September 2008.

Enermark (Enermark Inc.). 2008. *Application for Approval of the Enerplus Resources Fund Kirby Oil Sands Project Phase 1*. Submitted to Alberta Environment and the Energy Resources Conservation Board. September 2008.

RAX (Rio Alto Exploration Ltd.). 2002. *Kirby Project Application for Approval to Alberta Energy and Utilities Board and to Alberta Environment*. Volumes 1, 2, 3, 5, 6 and 7. Prepared by Golder Associates Ltd. Calgary, AB.

34. Page 374, SIR Response 167 and Page 375-376, SIR response 168

Similar to how CNRL intends to adaptively manage its operations; the assessment process is refined and adapted through its iterative use in the regulatory process. Rank is defined as a relative position. The ranking systems presented do not describe the relative state of fish species diversity, habitat diversity, and predator/prey species ratios in the study area because all sites are ranked similarly. If all sites are assessed at the same or similar diversity, and no point of comparison is presented (as requested) there is no reference point from which to understand or contextualize the results. Either the ranking systems need to be adjusted to better describe the range of conditions in the study area, or they need to be presented in the broader regional and provincial context.

a. Either adjust the ranking systems to better describe the local range of relative positions for species diversity, habitat diversity and predator/prey species ratios, or using the ranking systems presented, place the assessed ranks in a regional and provincial context using a broad suite of regional and provincial watercourse and waterbody data.

Response:

a. Canadian Natural does not believe adjusting the ranking system is necessary. As described below, the ranking system, as presented, does accurately reflect the relative state of fish species diversity, habitat diversity and ecosystem diversity in the Project Area. Furthermore this ranking system has been applied and accepted for numerous applications in the region, including Canadian Natural (2007), Cenovus (2010), Dover OPCO (2010), EnCana (2008) and MEG (2008), as described in the response to Round 1 SIR 167 (Canadian Natural 2012).

The diversity rankings of watercourses and waterbodies for the Project EIA, and previously completed EIAs that used the same ranking system, are provided in Table 34-1. To place the assessed Project rankings into a regional context projects located within the Conklin area and north of Fort McMurray are provided. This demonstrates that the ranking system is not biased towards low rankings, but rather that the low rankings reported in the Application are indicative of the low diversity habitat within the Project Area.

Table 34-1 Summary of Diversity Rankings for Watercourses and Waterbodies for Various Projects in the Oil Sands Region

Project	Watercourse or Waterbody	Ranking			
		Species Diversity	Habitat Diversity	Ecosystem Diversity	Overall Diversity
EnCana 2008	Christina Lake	3 - moderate	4 - high	4 - high	4 - high
	Sunday Creek	2 - low	2 - low	4 - high	3 - moderate
	Unnamed Tributary	1 - very low	2 - low	1 - very low	1 - very low
Canadian Natural 2007	Ipiatik Lake	1 - very low	n/a	2 - low	2 - low
	Wiau Lake	1 - very low	3 - moderate	2 - low	2 - low
	Unnamed Lake 1 (Big Muskeg Lake)	1 - very low	3 - moderate	3 - moderate	3 - moderate
Cenovus 2010	Sawbones Creek	1 - very low	1 - very low	2 - low	1 - very low
	WB-13	1 - very low	3 - moderate	1 - very low	1 - very low
	UNT-6	1 - very low	1 - very low	1 - very low	1 - very low
MEG 2008	Winifred River	3 - moderate	2 - low	3 - moderate	3 - moderate
	Waterbody 1	1 - very low	3 - moderate	1 - very low	2 - low
	Watercourse 1	1 - very low	2 - low	1 - very low	2 - low
Dover OPCO 2010	Ells River	3 - moderate	2 - low	4 - high	3 - moderate
	Snipe Creek	1 - very low	2 - low	3 - moderate	2 - low
	Chelsea Creek	1 - very low	1 - very low	3 - moderate	2 - low

n/a = data not available.

In addition, a number of watercourses and waterbodies were selected from within the Project RSA and, using the same ranking system as the Project, diversity rankings were applied (Table 34-2). These rankings were completed using the extensive amount of historical information available for these watercourses and waterbodies. The results provide a point of comparison for watercourses and waterbodies within the same RSA. As demonstrated in Table 34-2 a lower diversity ranking was identified for headwaters within the Project Area, based on the species and habitat present, relative to the larger watercourses found in the RSA.

In summary, the ranking for the Project is considered appropriate. The results shown in Tables 34-1 and 34-2 demonstrate that the diversity ranking system is not biased towards low rankings, but rather that the low rankings reported in the Application are indicative of the low diversity habitat within the Project Area.

Table 34-2 Summary of Diversity Rankings for Watercourses and Waterbodies within the Regional Study Area

Watercourse or Waterbody	Ranking			
	Species Diversity	Habitat Diversity	Ecosystem Diversity	Overall Diversity
Waterbody				
Winefred Lake	2 - low	4 - high	4 - high	4 - high
Lac La Biche	1 - very low	4 - high	4 - high	3 - moderate
Cowper Lake	1 - very low	3 - moderate	4 - high	3 - moderate
Grist Lake	2 - low	4 - high	4 - high	4 - high
Seibert Lake	1 - very low	4 - high	4 - high	3 - moderate
Pinehurst Lake	1 - very low	4 - high	4 - high	3 - moderate
Wolf Lake	1 - very low	4 - high	4 - high	3 - moderate
Touchwood Lake	1 - very low	4 - high	4 - high	3 - moderate
Edwards Lake	1 - very low	3 - moderate	2 - low	2 - low
Glover Lake	1 - very low	3 - moderate	2 - low	2 - low
Watercourse				
Christina River	2 - low	3 - moderate	4 - high	3 - moderate
Jackfish River	2 - low	3 - moderate	4 - high	3 - moderate
Sand River	2 - low	3 - moderate	4 - high	3 - moderate
Birch Creek	1 - very low	2 - low	3 - moderate	2 - low

References:

Canadian Natural (Canadian Natural Resources Limited). 2007. *Kirby In-Situ Oil Sands Project Application for Approval*. Volumes 1-6. Submitted to Energy Resources Conservation Board and Alberta Environment. September 2007. Calgary, AB.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Cenovus (Cenovus FCCL Ltd). 2010. *Application for the Approval of the Narrows Lake Project.* Aquatic Resources Fish and Fish Habitat Baseline: Volume 4, Appendix 4-VII. Submitted to Energy Resources Conservation Board and Alberta Environment. June 2010.

Dover OPCO (Dover Operating Corp.). 2010. *Application for approval of Dover Operating Corp. Dover Commercial Project*. Volumes 1 to 6. Submitted to Alberta Energy Resources Conservation Board and Alberta Environment. December 2010. Calgary, AB.

EnCana (EnCana FCCL Ltd.). 2008. *Fish and Fish Habitat Baseline Report for EnCana Christina Lake Thermal Expansion Project, Phase E, F and G*. Submitted to EnCana FCCL Oils Sands Ltd. September 2008.

MEG (MEG Energy Corp.). 2008. *Application for the Approval of the Christina Lake Regional Project*. Aquatic Resources Fish and Fish Habitat Baseline: Volume 4, Appendix 4-V. Submitted to MEG Energy Corporation. August 2008.

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35. Page 389-390, SIR Response 179

CNRL provides a discussion of the terrestrial LSA extent being limited to 500 metres beyond the ground disturbances associated with the project.

a. Similar to CNRL's intent to adaptively manage its operations and impacts, the assessment process is refined and adapted through its iterative use in the regulatory process. Defining the LSA boundary using a 500 metre extent beyond planned infrastructure challenges reviewers due to the frequency with which project infrastructure locations change between the EIA application and project implementation, and biological concerns that are not always well considered (e.g., impacts of exploration, movement corridors, rare plant presence). Discuss all areas of impact that may not have been adequately considered due to the chosen LSA.

b. CNRL states that seismic and exploration is included in the terrestrial baseline. However, given the LSA is limited to 500 metres beyond ground disturbance, confirm the full extent of seismic and exploration in support of the project was not included within the LSA. Provide a map depicting the extent of exploration conducted in support of the project in contrast to the LSA. If the areal extend of exploration undertaken in support of the project is not circumscribed by the boundary of the LSA, adjust the LSA and refine the impact predictions presented.

c. CNRL indicates that at this time it has no plans to conduct further seismic testing. This is not considered reasonable given current industry practice. Provide an estimate of the likely extent of seismic and exploration expected to be undertaken in support of project development and operations. Separate 3D and 4D seismic. Identify the likely spacing, periodicity and areal and temporal extent of the impact. Provide an assessment of the impact on terrestrial resource

Response:

LSA Boundary

As described in Section 2.1.2 of the *Guide to Preparing Environmental Impact Assessment Reports in Alberta* (the Guide; AENV 2011), "the Local Study Area (LSA) is the area surrounding and including the Project Area [i.e., the Project footprint, as defined Section 2.1.1 of the Guide], where there is a reasonable potential for immediate environmental impacts due to ongoing project activities". As a result, the LSA has been defined as a smoothed 500 m buffer around infrastructure directly associated with the Project footprint under the Application Case, including plant sites, well pads, rights-of-way and ancillary facilities (e.g., camps, borrow areas), and does not incorporate disturbances that are already on the landscape and previously approved or activities that are outside the scope of the Project and subject to separate approval process.

The 500 m buffer used to define the LSA is based on scientific rationale for areas where potential indirect effects of the Project may occur as described in Volume 5, Section 1.3.4 of the December 2011 Application (Canadian Natural 2011). These include wildlife zones of influence (i.e., indirect habitat loss due to effects from human use and access, light, and noise), potential indirect losses of wetlands and wetlands habitat resulting from changes to surface hydrology, and dust effects to vegetation.

Canadian Natural believes that the boundaries of the Terrestrial LSA are appropriate for completion of the EIA, to provide an understanding of the nature of the Project and effects that the Project is expected to have on the environmental setting in which it would occur, as per Section 1.1 of the Guide, and that the potential effects are adequately assessed to inform a decision on completeness of the EIA. The criteria used to define the LSA for the Project are consistent with the methods used in several past EIAs for in situ projects that have received regulatory approval, and guidance from regulators. If the LSA were to be defined on a broader scale (e.g., the extent of the leases, which may include areas where no extractable bitumen is present and therefore no associated surface facilities are required in these areas), this could lead to potential dilution of the predicted magnitude of effects at the local scale. The sizing of the LSA is representative because it considers the Project at full build, so that the assessments for the terrestrial components are based on the maximum disturbance to terrestrial resources over the life of the Project.

Of the specific examples provided in the above request, wider-spread effects of the Project (e.g., effects to movement corridors for wide ranging species) are more appropriately assessed at the scale of the RSA. The presence of rare plants will be confirmed prior to disturbance through detailed vegetation surveys completed as part of the Pre-Disturbance Assessment process prior to construction of the final Project footprint, which will include specific discussion of mitigation for identified rare plant occurrences. A discussion of how current and future exploration are considered in the regulatory process is provided below.

Baseline

Canadian Natural has met the requirements of the Final Terms of Reference (TOR) with respect to the inclusion of "exploration conducted in support of the Project in contrast to the LSA" in the EIA.

The Wildlife Baseline Information Section of the Final TOR for the Project (Section 3.7.1[B] included on CD With the December 2011 Application) requires Canadian Natural to "describe and map existing wildlife habitat and habitat disturbance (including exploration activities)." Canadian Natural has provided this information in Volume 5, Sections 1.3.4.1 and 1.3.4.2, as part of the baseline assessment for the EIA, as requested in the Final TOR. The impacts of this existing disturbance are accounted for in both the LSA and RSA.

Canadian Natural's approach is also consistent with the Guide, which states that "Proponents should ensure that all resource delineation disturbances for the project (e.g., seismic lines and exploration operations) are included in the Baseline Case Assessment" (Guide Section 2.2.1). Canadian Natural's approach is also consistent with Section 2.2.2 of the Guide, which gives Proponents the option to address the impacts associated with resource delineation activities (e.g., seismic) carried out prior to the Project in either the Baseline Case or the Application Case. Canadian Natural chose to address the impacts in the Baseline Case.

Canadian Natural's Project LSA boundary was defined to be consistent with ESRD's requirements regarding baseline activities and ESRD's definition and intent of the LSA (Guide 2.1.2).

As described above Canadian Natural has completed the EIA Report in accordance with ESRD's Final TOR and Guide so adjusting the LSA and/or updating the impact predictions/assessment to include disturbances associated with exploration conducted in support of the Project is not warranted.

Planned Development Case

Canadian Natural has met the requirements of the Final TOR with respect to the requirement to address future seismic testing or expected exploration and monitoring.

The Wildlife Impact Assessment Section of the Final TOR for the Project require Canadian Natural to "Describe and assess the potential impacts of the Project to wildlife and wildlife habitats, considering: potential effects on wildlife from the Proponent's proposed and planned exploration, seismic and core hole activities, including monitoring/4D seismic" (Appendix 3-1, Section 3.7.2[A](f)). In the Guide ESRD defines planned as "any project or activity that has been publicly disclosed up to six months prior to the submission of the Proponent's Application and EIA Report" (Guide Section 2.2.3). Canadian Natural can say, with confidence, that six months prior to the submission of the Application and EIA areas of future oil sands exploration or seismic were not known, therefore an assessment of the impact of these activities on wildlife and wildlife habitat is not required as part of this EIA.

Also, if Canadian Natural was aware of any seismic or exploration activity six months prior to the filing of the EIA and Application, as per the Guide (Section 2.2.3), this information would have been included in the PDC, therefore the boundaries of the Project LSA would not be affected.

Regulatory Requirements for Seismic or Exploration

As described below, the potential impacts of seismic or exploration are addressed through other regulatory processes administered by ESRD.

Approval under the Exploration Regulation (284/2006) of the *Mines and Minerals Act* is required for all seismic activities. Authorizations are administered by ESRD under the *Exploration Regulation* and associated exploration directives of the *Mines and Minerals Act*. Exploration activity related to oil sands resource exploration for proposed in situ development is directed by the *Code of Practice for Exploration Operations* pursuant to EPEA. The Code of Practice outlines the requirements of an Activities Plan that Canadian Natural must complete to carry-out the exploration activity. Notice must be filed prior to exploration operations. Once oil and gas exploration is completed, Canadian Natural is required to file a final plan (within 90 days following the date of approved program completion to ESRD) (ERCB 2010).

On public land Canadian Natural must submit a Geophysical Field Report (GFR) to obtain an authorization from ESRD. The Policy and Procedures Document for Submitting The Geophysical Field Report Form (Government of Alberta 2006) outlines the submission requirements of the GFR. Canadian Natural will complete a mandatory on-site evaluation prior to completion of the GFR to properly evaluate existing field conditions prior to implementation of the program. Through the GFR Canadian Natural will provide site-specific details regarding the seismic program and mitigation of potential environmental issues associated with the program. Details regarding how the activity will meet all applicable environmental standards are provided by Canadian Natural in the GFR. Areas of special concern, including caribou areas, are identified and mitigation pertaining to each area is proposed.

Mitigation

As stated in Canadian Natural's Corporate Statement on Environmental Protection, Canadian Natural is committed to mitigating the environmental impacts of Canadian Natural's business during project planning, exploration, drilling, construction, operations and decommissioning (Volume 1, Figure 8.1-1).

Upon approval of an exploration program, Canadian Natural will comply with all terms and conditions of approvals and requirements of Exploration Regulation as described above.

Canadian Natural will use low impact seismic techniques (as stated in the response to Round 1 SIR 204 [Canadian Natural 2012]), to minimize the extent of environmental disturbance, including:

- where possible, narrow cutting of lines throughout seismic programs;
- cutting only the necessary width for forest cover type and topography;
- using avoidance cutting to retain large timber and leave more habitat intact;
- using mulchers to reduce duff and rooting layer disturbance and improve the rate of vegetation regeneration;
- using wandering lines and incorporation of line of site breaks every 200 m;
- where lines cross existing clearings the openings will be dog-legged to reduce line of site;
- using of existing lines for access, and avoidance of areas where significant regrowth is present to the extent possible;
- spacing and line width (typical three-dimensional low impact seismic program) as follows:
  - source lines: 125 m length, mulched to maximum 3.0 m width; and
  - receiver: 100 m length, mulched to maximum 2.0 m width.
- hand cutting in more sensitive areas (e.g., near watercourses);
- as a general practice, source and receiver lines will be hand cut to narrower widths for foot access where the following circumstances warrant:
  - 1.75 m width if terrain conditions dictate (e.g., sensitive soils, steep hills);
  - 0.5 m width for a distance of 10 m from the edges of watercourses or waterbodies;
  - 1.75 m through riparian areas; and
  - 1.75 m for a distance of 45 m within the outermost edge of the riparian area.
- drilling shot holes a maximum of 45 m from the outermost edge of riparian areas.

Buffer zones will be created at watercourses and watercrossings where a mechanical crossing has not been approved. For example, Canadian Natural will apply a 10 m buffer from the water's edge on water bodies and from the bank immediately next to the water channel on watercourses. All program lines will terminate at this point. Canadian Natural will hand cut all lines in the riparian area to reduce the amount of disturbance to approximately as little as 0.5 m width.

Site specific situations will be discussed with the ESRD at the planning and scouting stages of all seismic programs to determine the best use of existing lines. Reuse portions of existing lines are expected to be narrow and meandering around patches of enhanced growth.

Watercourse crossings will be identified and evaluated prior to commencement of any seismic activity to ensure the best type of cross location and method is chosen. Canadian Natural will adhere to the *Water Act Code of Practice for Watercourse Crossings* (Government of Alberta, 2007) and Fisheries and Oceans Canada operational statements (e.g., DFO 2010) in applicable situations.

Program areas will be inspected the following spring, and surface damage, if any, will be reclaimed and residual garbage will be removed. Canadian Natural is required to apply for a reclamation certificate within 2 years of the program completion.

Within caribou zones, seismic programs are included in Canadian Natural's Caribou Protection Plans, which require approval by ESRD.

References:

AENV (Alberta Environment). 2011. The *Guide to Preparing Environmental Impact Assessment Reports in Albert – Updated February 9, 2011.* Alberta Environment, Environmental Assessment Team, Edmonton, Alberta. EA Guide 2009-2. 26 pp.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Volumes 1 to 6. Submitted to Alberta Environment and Water, and the Energy Resources Conservation Board. December 2011.

Canadian Natural. 2012. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Supplemental Information*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

ERCB (Energy Resources Conservation Board). 2010. *Upstream Oil and Gas Authorizations and Consultation Guide.* October 26, 2010 (incorporating revisions to May 13, 2011). 96 pp.

DFO (Fisheries and Oceans Canada). 2010. *Ice bridges and snow fills – Alberta operational statement. Version 3.0.* Available online at: http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/ab/os-eo10-eng.htm.

Government of Alberta. 2006. Policy and Procedures Document for Submitting the Geophysical Field Report Form. October 2006. 26 pp. + Appendices.

Government of Alberta. 2007. *Environmental Code of Practice for Watercourse Crossing*. *Water Act* – Water (Ministerial) Regulation. Consolidated to include amendment of

2001/03/16 and in force as of 2001/04/01, and amendment of 2003/07/29 in force as of 2003/07/30, and amendment of December 1, 2006 in force as of 2007/02/15.

36. Page 390-396, SIR Response 180

a. Response a: The original question requested a map identifying the location of validation data and the date validation data were collected. CNRL provides a discussion of the data and for several of the models indicates that location data cannot be presented due to data sharing agreements.

i. Provide a map of the generalized location data collected for model validation.

ii. Identify the date data were collected. If multiple datasets were used and data were not collected using similar methods, effort and seasonal timing, provide a rationale for why datasets were included and any caveats to the interpretation of the results arising from the inclusion of data collected using dissimilar methods, timing and/or effort.

iii. Provide a discussion of the merit/implications of presenting models that cannot be fully reviewed due to data sharing agreements that prevent presentation of data used.

b. Response a: CNRL indicates data were not available for validation of the RSA-scale beaver and western toad models, nor for the LSA and RSA scale models for Canada warbler, the old growth forest bird community or rusty blackbird. CNRL argues that the model structure and predictive output conform to the current state of knowledge regarding the ecology and habitat preferences of these species. This argument was repeated in the responses to b and c. Given that it is assumed the models were developed using the best available knowledge regarding the ecology and habitat preferences of these species, CNRL's rationale results in a circular argument. Validation efforts are intended to corroborate the model function with respect to its development using this information. It is recommended CNRL either withdraw these models, or outline a plan to collect appropriate data and undertake validation efforts to support their inclusion. Confirm which approach CNRL will undertake.

c. CNRL quotes Shell (2010) …*the use of Mike Russell's RSFs (M.Sc. Thesis 2008 – University of Alberta) would be more appropriate as they account for individual variability and edge effects.* However, having said this CNRL does not discuss why Mike Russell's RSFs were not used. Provide this discussion.

d. CNRL argues in several places in the response to SIR 180 *that the study area used for development of [the model]…and the Project LSA [or RSA] are ecologically similar as they both fall within the Central Mixedwood Natural Subregion or a variation of this argument (e.g. same natural subregion, both areas are dominated by upland mixedwood and treed peatlands, both datasets were collected along a wide range of ecological gradients that occur in the RSA, and same ecological subregion).* Provide support for the conclusion that because the project study areas are within the same ecological subregion that they are ecologically similar with respect to the factors to which the modeled species are responding. Consider, but do not limit the supporting information to distribution of habitat, size, shape and arrangement of habitat, and stage of habitat succession.

e. Provide a table of all habitat models presented in the CNRL Kirby Expansion EIA, comparing and contrasting validation with the methods recommended in Muir 2011.

Muir, J.E. V.C. Hawkes, K.N. Tuttle, and T. Mochizuki. 2011. Synthesis of Habitat Models used in the Oil Sands Region. Cumulative Environmental Management Association, Fort McMurray, AB. CEMA Contract No. 2010-0034 RWG. 61 pp.

Response:

a.

i. Geographic location of the data used to validate species-specific models was presented in Volume 5, Appendix 5-1 Wildlife Modelling of the December 2011 Application (Canadian Natural 2011), and are summarized in Table 36-1. All data were collected in ecologically comparable areas in northeastern Alberta, as described in the response to part d.

As stated in Volume 5, Appendix 5-1, Section 1.2, data for the barred owl model were collected within an 84,000 km^2 area around the town of Athabasca in north-central Alberta (Russell 2008), and data for the western toad model were collected in the Lake Utikama region of Alberta (Browne 2010), which is about 175 km southwest of the RSA. The data used for production of these two models are the property of the authors, and are not publicly available.

A previously developed Resource Selection Probability Function (RSPF) model developed from beaver dam and lodge data collected within portions of the Athabasca River watershed in northeast Alberta was used to predict the probability that sites in the LSA were previously and currently selected by beaver to build a dam or lodge (AOSC 2009). The general locations of data used to create the models are shown in Figure 36-1.

Table 36-1 Construction and Validation Information for Wildlife Models Used in the Kirby Expansion Project Wildlife Assessment

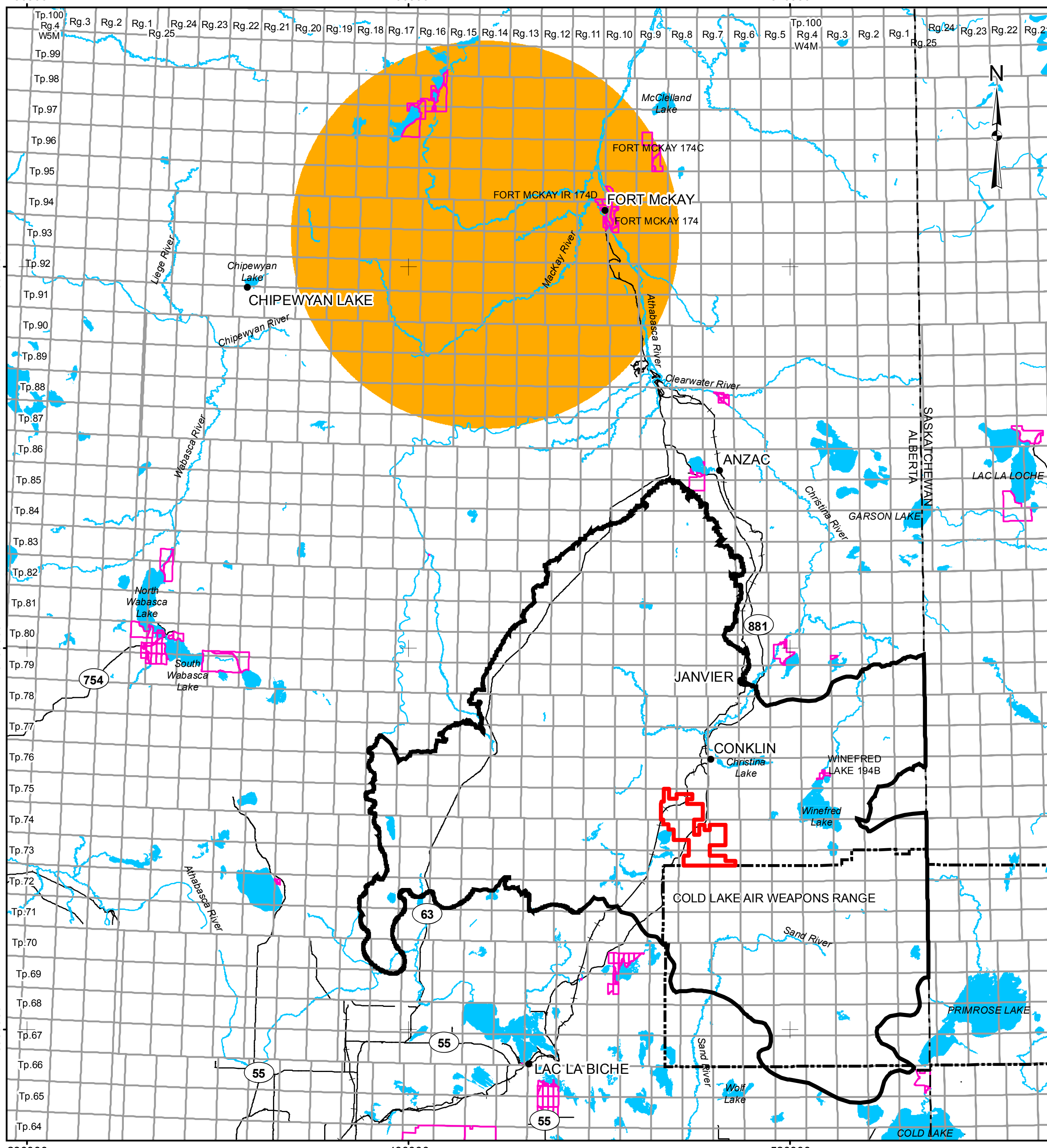
Species	Study Area	Model	Reference	Model Construction	Validation type[a]	General Location	Time Period	Muir et al. 2011 Validation Recommendation[b]	Comments
Barred Owl	LSA	RSF	Russell (2008)	radio telemetry data from Athabasca	K-fold cross-validation (Boyce et al. 2002)	Athabasca, Alberta	March 2004 to August 2005	k-fold cross-validation	no barred owls were detected in the LSA
	RSA	HSI	Shell (2007)	expert-based HSI using RLCC data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Beaver	LSA	RSPF	AOSC (2009)	MacKay River beaver loge and dam data	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	MacKay River, Alberta (Figure 38-1)	fall, 2008	-	Unbiased data not available; survey techniques do not provide exact locations for lodges and dams
	RSA	HSI	Westworth, Brusnyk and Associates (1986)	expert-based HSI using RLCC and hydrological data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Canada lynx	LSA	RSPF	Keim et al. (2011)	2009 winter tracking data	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	LSA (Figure 38-2)	winter 2011	-	data used for additional validation were collected in the LSA during baseline winter track transect surveys (Volume 5, Appendix 5-1, Section 1.2.3.3) which were conducted in the winters of 2001, 2008, 2009 and 2011 (Wildlife Baseline Report, Section 2.1, Table 2, included on CD with the December 2011 Application).
	RSA	RSF	Shell (2007)	winter tracking data	K-fold cross-validation (Boyce et al. 2002)	Oil Sands Region north and south of Fort McMurray (Figure 38-2)	1999 to 2005	K-fold cross-validation (Boyce et al. 2002)	
Canadian Warbler	LSA	HSI	Shell (2007)	expert-based HSI using AVI data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	only one observation in LSA
	RSA	HSI	Shell (2007)	expert-based HSI using RLCC data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Moose	LSA	RSPF	Wasser et al. (2011)	pellet group data from StatoilHydro (2008)	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	Oil Sands Region south of Fort McMurray (Figure 38-3)	winter 2006, 2007	-	-
	RSA	RSPF	Wasser et al. (2011)	pellet group data from StatoilHydro (2008)	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	Oil Sands Region south of Fort McMurray (Figure 38-3)	winter 2006, 2007	-	
Old Growth Birds	LSA	HSI	Shell (2007)	AVI old growth polygons	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	accuracy of models is reflected by accuracy of vegetation mapping
	RSA	HSI	Shell (2007)	RLCC old growth percentages based on Addison (2003)	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Rusty Blackbird	LSA	HSI	Shell (2007)	expert-based HSI using AVI data	Author review, model calibration, external review of the model	LSA	June, 2011	Author review, model calibration, external review of the model, test with field data.	only seven observations in LSA
	RSA	HSI	Shell (2007)	expert-based HSI using RLCC data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Western Toad	LSA	RSF	Browne (2010)	radio telemetry data from Utikima Lake	K-fold cross-validation (Boyce et al. 2002)	Lac laBiche, Alberta	May-October 2005	K-fold cross-validation (Boyce et al. 2002)	toad surveys collect data on calling males, cannot be used for summer foraging or winter hibernating models
	RSA	HSI	Shell (2007)	expert-based HSI using RLCC data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	
Woodland Caribou	LSA	RSPF	Wasser et al. (2011)	pellet group data from StatoilHydro (2008)	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	Oil Sands Region south of Fort MacMurray (Figure 38-3)	winter 2006, 2007	-	too few observations in LSA to use for LSA validation
	RSA	RSPF	Wasser et al. (2011)	pellet group data from StatoilHydro (2008)	Mean squared error (Wackerly and Scheaffer 2008), goodness of fit (Hosmer and Lemeshow 2000)	Oil Sands Region south of Fort MacMurray (Figure 38-3)	winter 2006, 2007	-	
Yellow Rail	LSA	HSI	Shell (2007)	expert-based HSI using AVI data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	no yellow rail observations in LSA, accuracy of models is reflected by accuracy of vegetation mapping
	RSA	HSI	Shell (2007)	expert-based HSI using RLCC data	Author review, model calibration, external review of the model	n/a	-	Author review, model calibration, external review of the model, test with field data.	

[a] Model validation approaches used are described in the Wildlife Habitat Modelling appendix (Volume 5, Appendix 5-1, Section 1.2).

[b] n/a where indicated as "-" (not applicable), Muir et al. (2011) did not provide recommendations regarding validation of RSPFs.

n/a = Not available.

- = Not applicable.



LEGEND

- • COMMUNITY
- PAVED ROAD
- RAILROAD
- WATERCOURSE
- INDIAN RESERVE
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- AREAS OF BEAVER DATA COLLECTION FOR THE LOCAL STUDY AREA SCALE RESOURCE SELECTION PROBABILITY FUNCTION

50 0 50

SCALE 1:1,800,000 KILOMETRES

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), AND FROM IHS ENERGY INC.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

AREAS OF BEAVER DATA COLLECTION FOR THE LOCAL STUDY AREA SCALE RESOURCE SELECTION PROBABILITY FUNCTION

Canadian Natural

PROJECT		12-1346-0014	FILE No.
DESIGN	BS	05 Nov. 2012	SCALE AS SHOWN REV. 0
GIS	SG	11 Dec. 2102	
CHECK	BS	11 Dec. 2102	FIGURE: 36-1
REVIEW	MJ	11 Dec. 2102	

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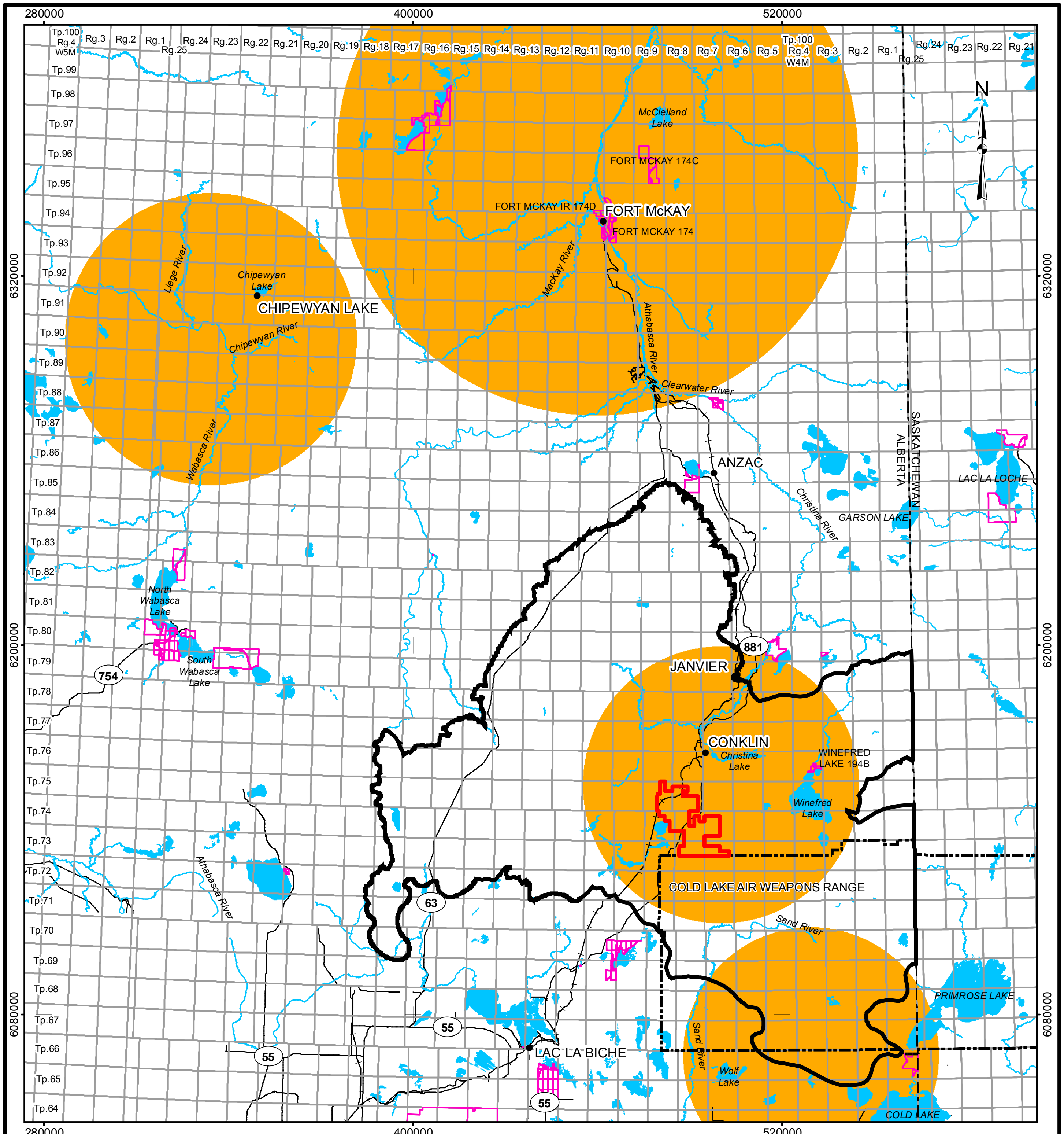
Model validation was conducted for the LSA scale Canada lynx RSPF using winter track transect data collected in and around the LSA (Volume 5, Appendix 5-1, Section 1.2.3.3), which were presented in the Wildlife Baseline Report (Section 3.3.1.1, Figure 12, included on CD with the December 2011 Application). Generalized locations for winter track transect data used for construction and validation of the RSA scale Canada lynx Resource Selection Function (RSF) model are shown in Figure 36-2.

Resource selection models were estimated and validated for wintering moose and woodland caribou from pellet group locations detected by scat detection dogs between January and March 2006 and 2007 in northeast Alberta (StatoilHydro 2008; Wasser et al. 2011). The general locations of these data are shown in Figure 36-3.

ii. The time period that data were collected for model validation are provided in Table 36-1.

Pooling of data for the purposes of model construction was appropriate because the survey methods used for data collection did not vary from one season or year to the next. Although some variation in survey effort was present between years, this did not compromise the validity of pooling data. Differences in the timing of data collection for model construction and validation result in data that reflect the natural variations that inherently exist in ecological systems. Habitat associations may vary over time due to population cycles of prey (e.g., Canada lynx due to the 10-year snowshoe hare population cycle) or due to changes in the severity of winter from one year to the next. Therefore, model predictions may vary over time due to changes in habitat associations, as well as due to natural variations. However, natural variation in habitat associations over time for the wildlife Key Indicator Resources (KIR) used in the EIA are not expected to be so dramatic as to compromise the usefulness of habitat suitability models that were applied.



LEGEND

- COMMUNITY
- PAVED ROAD
- RAILROAD
- WATERCOURSE
- INDIAN RESERVE
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- AREAS OF CANADA LYNX WINTER TRACK TRANSECT DATA COLLECTION FOR RESOURCE SELECTION FUNCTIONS

50 0 50

SCALE 1:1,800,000 KILOMETRES

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

AREAS OF CANADA LYNX WINTER TRACK TRANSECT DATA COLLECTION FOR RESOURCE SELECTION FUNCTIONS

Canadian Natural

PROJECT		12-1346-0014	FILE No.
DESIGN	BS	12 Oct. 2012	SCALE AS SHOWN REV. 0
GIS	AB	08 Nov. 2012	
CHECK	BS	11 Dec. 2102	FIGURE: 36-2
REVIEW	MJ	11 Dec. 2102	

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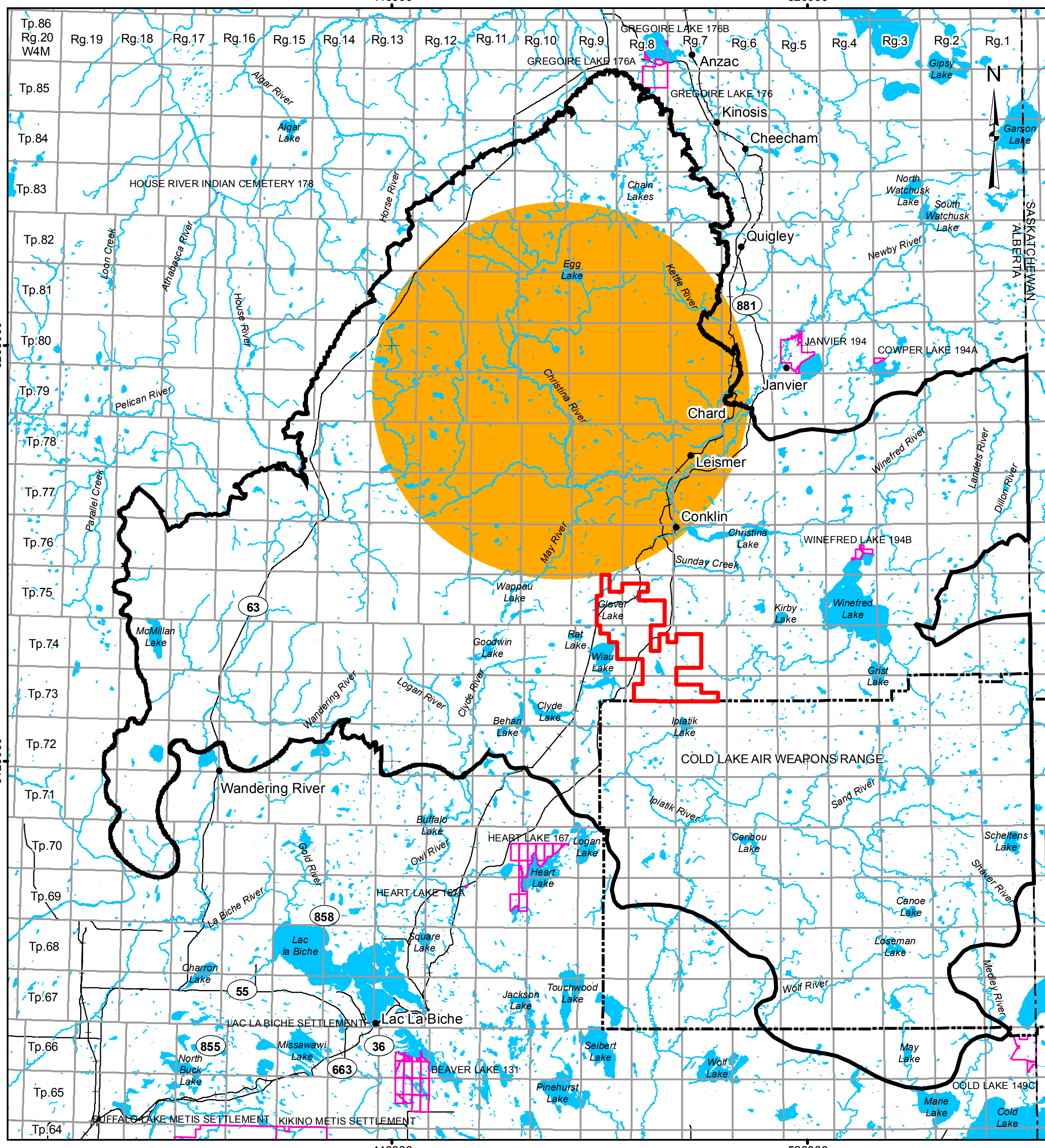

LEGEND

- COMMUNITY
- PAVED ROAD
- RAILROAD
- INDIAN RESERVE
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- AREAS OF MOOSE AND WOODLAND CARIBOU DATA COLLECTION FOR THE RESOURCE SELECTION PROBABILITY FUNCTIONS

35 0 35

SCALE 1:1,100,000 KILOMETRES

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

AREAS OF MOOSE AND WOODLAND CARIBOU DATA COLLECTION FOR THE RESOURCE SELECTION PROBABILITY FUNCTIONS

Canadian Natural

PROJECT	12-1346-0014		FILE No.	
DESIGN	BS	05 Nov. 2012	SCALE AS SHOWN	REV. 0
GIS	AB	08 Nov. 2012	FIGURE: 36-3	
CHECK	BS	11 Dec. 2012		
REVIEW	MJ	11 Dec. 2012		

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iii. Canadian Natural is confident that the models used provide a reasonable assessment for estimating the direct and indirect effects of the Project on wildlife and wildlife habitat using the best available information (Table 36-1). Although source data for some models are not available, the models themselves can be reviewed. The methods used in model construction and validation, in addition to details regarding model structure and underlying assumptions, are described in considerable detail in the Wildlife Habitat Modelling Appendix (Volume 5, Appendix 5-1). The LSA barred owl (Russell 2008), LSA western toad (Browne 2010), LSA Canada lynx (Keim et al. 2011), and the LSA and RSA moose and woodland caribou (Wasser et al. 2011) models are published either as theses or journal articles, and have thus already been subjected to additional peer review. The general locations of data collection have been provided in the response to part ai (Table 36-1). As these models can be fully reviewed and are considered the best models available for assessing the effects of the Project on wildlife and wildlife habitat, Canadian Natural believes there is considerable merit in presenting and applying these models and conversely does not believe there are any substantive implications in doing so.

b. Data were not available for validation of the RSA-scale beaver and western toad models, or for the LSA and RSA scale models for Canada warbler, the old growth forest bird community and rusty blackbird (Table 36-1). Although validation of models is desirable, the application of unvalidated models is unavoidable in some cases, particularly for rare species and those for which baseline survey methods may not support the collection of data that is appropriate for model validation.

In the case of the RSA-scale beaver model, validation would require data on the precise locations of beaver presence on the landscape. However, baseline beaver surveys for the Project are focused on collecting data suitable for determining relative abundance estimates (e.g., lodges/km of water course). As a result, precise locations of lodges and food caches are not collected. Large data sets are needed for accurate estimates of the relative abundance of beaver, which in turn are necessary for producing an accurate baseline against which assessment predictions can be made and future monitoring data may be compared. Collecting data for validating the RSA beaver model would require increases in the accuracy of beaver food cache and lodge locations at the cost of survey efficiency and sample size. Given the importance of relative abundance measures in baseline sampling (i.e., the primary objective of wildlife baseline sampling) and the simplicity, consistency and well understood characteristics of beaver habitat associations, a tradeoff of sample size for location precision to statistically validate the RSA scale model was considered unwarranted.

For western toad, as stated in the response to Round 1 SIR 180b, the precise breeding locations of toads detected during baseline surveys could not be determined in the field, and were instead determined using estimates of distance and bearing. These locations cannot be used to determine model reliability. In addition, amphibian surveys are not conducted in such a way as to cover all ecological gradients and habitat types that are present in the LSA, which is needed for the data to be appropriate for statistical model validation. Instead, amphibian surveys are planned to focus on wetlands large enough to be present in Alberta Vegetation Inventory (AVI) data and aerial photography, which introduces a bias that renders the data inappropriate for model validation. The data are intended to be, and are appropriate for detecting the presence and relative abundance of various amphibian species to produce an accurate baseline against which assessment predictions can be made and future monitoring data may be compared. Therefore, insufficient data are available for validation of the RSA-scale HSI model.

Canada warbler and rusty blackbird models cannot be validated because sufficient data are not available due to the rarity of these species. For example, despite focused surveys in and around the LSA, no Canada warblers and only one rusty blackbird were observed.

The old growth forest bird community model selects old growth stands and then includes sensory disturbance buffers for estimating the indirect effects of disturbance. As a result, field data for the locations of individual old growth bird species are not used to validate this model. Old growth forest is mapped to be within +/- 5 years 80% of the time at the LSA scale, according to AVI standards (ASRD 2005). At the RSA scale, the abundance of old growth forest was estimated from relationships between the Regional Land Cover Classes (RLCCs) and predicted levels of old growth for each class in the region based on the midpoint values for age class variability presented by Andison (2003) (Section 4.2.1.3 of the Terrestrial Vegetation, Wetlands and Forestry Baseline Report).

Canadian Natural used the best models that were available for assessing the direct and indirect effects of the Project on wildlife and wildlife habitat. Model validation has been conducted where it was feasible to do so. For some species, model validation is not feasible. However, based on the model validation that has been conducted, the availability of data, and the current state of knowledge regarding the ecology and habitat preferences of these species, the models are considered to be appropriate for the assessment of the effects of the Project and other planned developments on wildlife and wildlife habitat. Canadian Natural believes that the unvalidated models are appropriate. Given that no validated models are available for some species and scales, Canadian Natural believes that withdrawing the unvalidated models would reduce the ability to provide quantification of the effects for these species and to do so would reduce the quality and accuracy of the assessment.

Canadian Natural recognizes the benefits of using validated models in the Wildlife Assessment, and where possible strives to do so, but as identified, there are significant challenges to only using validated models in the assessment. Canadian Natural also acknowledges that using validated models may allow for higher confidence in environmental consequence ratings in the assessment for wildlife KIRs. However taking into consideration the information presented above and in part e, Canadian Natural believes that the information provided through the use of unvalidated models still adds value to the wildlife assessment.

c. As described in Volume 5, Appendix 5-1, Section 1.2.1, Russell's RSF model (Russell 2008) was used to predict the effects of the Project on barred owl habitat at the LSA scale. However, the barred owl RSF model requires AVI data, and therefore could not be used at the RSA scale (Volume 5, Appendix 5-1, Section 1.2.1). A Habitat Suitability Index (HIS) model using Regional Land Cover Class data was used at the RSA scale (Table 36-1).

d. The LSA is approximately half wetlands ecotypes and half upland forest ecotypes. The upland forest types are about two-thirds coniferous and one third deciduous and mixedwood forest stands. About a quarter of the LSA, both upland and wetland, was burned between 2002 and 2007. Anthropogenic disturbance also makes up about 10% of the LSA in the Base Case.

   The habitat characteristics of the LSA fall within the range of habitat characteristics present within the areas of data collection for the validated RSF and RSPF models used in the EIA (i.e., LSA barred owl, LSA beaver, LSA western toad, LSA and RSA Canada lynx, the LSA and RSA moose and woodland caribou). Typical of the Central Mixedwood Region, the LSA and the areas from which data for the RSF and RSPF models were collected consists of upland areas that are a mix of deciduous stands dominated by aspen and white spruce or jack pine-dominated coniferous stands (NRC 2006). Wetlands are extensive, and are primarily fens and bogs dominated by black spruce (NRC 2006). Wildfires are common to the Central Mixedwood natural sub-region and portions of burned habitat are common in both the LSA and the habitats from which model data were collected. Additional details regarding data used for each model are provided below.

   Data for the beaver RSF were also collected in habitat that was approximately half wetlands ecotypes and half upland forest ecotypes. Upland forest stands occurred in relatively equal proportions of coniferous, mixedwood, and deciduous forest stands. Anthropogenic disturbance in the data collection habitat totaled approximately one sixth of the total area.

   Data for the moose and caribou RSPFs were collected in habitat that was about one third wetlands and two-thirds uplands. Upland habitats occurred in relatively equal proportions of coniferous, mixedwood, and deciduous forest stands. Anthropogenic disturbance in the data collection area totaled about one-tenth of the total area.

   Data for the Canada lynx models were collected in areas that were approximately half wetlands and half uplands. Upland habitats occurred in relatively equal proportions of coniferous, mixedwood and deciduous forest stands. Anthropogenic disturbance in the data collection area totaled about one tenth of the total area.

Data for the barred owl model were collected in habitat that was approximately one third wetlands and two thirds uplands. Upland forest ecotypes were approximately two thirds deciduous stands and one third a mix of coniferous and mixedwood forest stands. Anthropogenic disturbance in the area made up about one third of the total area.

Data were collected for the LSA western toad RSF in habitat that was approximately one half wetlands types and one half upland forest ecosite phases. Upland habitats occurred in relatively equal proportions of coniferous, mixedwood and deciduous forest stands. Anthropogenic disturbance in the data collection area totaled about one tenth of the total area.

In the absence of additional data for validation, it is reasonable to assume that wildlife within ecologically similar areas will exhibit similar habitat relationships. The key consideration is that the ecological gradients present in the sample data, such as the abundance and spatial distribution of ecosite phases, wetlands types and disturbance features, as well as the range of stages of habitat succession, are also present in the area over which model predictions are being calculated (i.e., the LSA and RSA).

e. A summary of the approaches used for model validation in the EIA relative to those recommended by Muir et al. (2011) is provided in Table 36-1. HSI models were reviewed by the authors (i.e., wildlife biologists at Golder or Matrix), calibrated so that model output aligned with the expected habitat suitability for the range of variables that occurs in the study areas, and reviewed externally (e.g., graduate committees, regulatory agencies), which are three of the four steps for model validation recommended by Muir et al. (2011). Appropriate and/or sufficient data were not available for testing some habitat suitability models with data (i.e., RSA barred owl, beaver and western toad, and the LSA and RSA Canada warbler, old growth forest bird community, rusty blackbird and yellow rail HSI models), which is the fourth step recommended for validating HSI models by Muir et al. (2011). Although testing with data could not be conducted in those cases, models were consistent with the best available scientific knowledge and professional judgment regarding habitat associations and requirements.

It is intuitive that the simpler the model and the more reliable and well understood the species-habitat associations are that the model is based on, the less necessary testing with data becomes to ascertain prediction confidence. In contrast, more complex models, or models based on poorly understood species-habitat associations that are highly variable across space and time, make determining prediction confidence difficult without testing predictions against relevant data.

For those KIRs to which an empirical model was applied and validated with data (i.e., LSA scale beaver, barred owl, and western toad and LSA and RSA scale Canada lynx, moose and woodland caribou models), the prediction confidence is rated as high (Volume 5, Section 4.4.2.2). In the case of the LSA scale barred owl model, although an empirically based model was used, the prediction confidence was downgraded to moderate because the output for indirect effects in the study area was judged to be less reliable based on professional judgment (Volume 5, Section 4.4.2.2). Prediction confidence is rated as high for the old growth forest bird community at the LSA scale, as this community is, by definition, associated with old growth forest and prediction confidence in the old growth forest mapping is high (see response to b) above).

Despite their foundation in simple, well understood habitat associations, prediction confidence was considered low to moderate for RSA scale beaver, barred owl and western toad models, and LSA and RSA scale Canada warbler, rusty blackbird and yellow rail models because observation data appropriate for statistical validation are not available (Volume 5, Section 4.4.2.2).

The LSA scale barred owl, RSA scale Canada lynx and LSA scale western toad RSFs were all validated using k-fold cross validation (Volume 5, Appendix 5-1, Section 1.2). This approach corresponds with Muir et al. (2011) recommendations for validating RSF models.

The LSA scale beaver and Canada lynx model, as well as the LSA and RSA scale moose and woodland caribou models are RSPFs (Volume 5, Appendix 5-1, Section 1.2). Linear regression evaluations from count data (Canada lynx validation; Keim et al 2011), the mean squared error (Wackerly and Sheaffer 2008) or the Hosmer and Lemeshow (2000) goodness of fit evaluations relative to predicted probabilities of occurrence were conducted on the Canada lynx, moose, woodland caribou and beaver RSPF models. To Canadian Natural's knowledge these goodness of fit methods were not considered in the review by Muir et al. (2011), but they are sound statistical methods that are readily available in published statistical literature.

References:

Andison, D. 2003. *Natural Levels of Forest Age-Class Variability on the Alberta-Pacific FMA*. Bandaloop Landscape-Ecosystem Services. November, 2003. Belcarra, BC.

AOSC (Athabasca Oil Sands Corporation). 2009. *Application for Approval of the Mackay River Commercial Project*. December 2009.

ASRD (Alberta Sustainable Resource Development). 2005. *Alberta vegetation inventory interpretation standards*. Version 2.1.1. Resource Information Management Branch. 99pp.

Boyce, M.S., P.R. Vernier, S.E. Nielsen and F.K.A Schmiegelow. 2002. *Evaluating resource selection functions*. Ecological Modelling. 157: 281-300.

Browne, C.L. 2010. *Habitat use of the western toad in north-central Alberta and the influence of scale*. Dissertation, University of Alberta, Edmonton, Alberta.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project. Volumes 1 to 6*. Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

Hosmer, D.W. and S. Lemeshow. 2000. *Applied Logistic Regression*. New York, USA: JohnWiley and Sons.

Keim, J.L., P.D. De Witt and S.R. Lele. 2011. *Predators choose prey over prey habitats: evidence from a lynx-hare system*. Ecological Applications 21(4):1011-1016.

NRC (Natural Regions Committee). 2006. *Natural Regions and Subregions of Alberta*. Compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852.

Russell, M.S. 2008. *Habitat selection of barred owls (Strix varia) across multiple spatial scales in a boreal agricultural landscape in north-central Alberta*. MSc Thesis. University of Alberta, Edmonton.

Shell (Shell Canada Limited). 2007. *Jackpine Mine Expansion & Pierre River Mine Project Application and Environmental Impact Assessment. Volumes 1, 2, 3, 4 and 5.* Submitted to Alberta Energy and Utilities Board and Alberta Environment, December 2007. Calgary, AB.

Wackerly, D. and W. Scheaffer. 2008. *Mathematical Statistics with Applications (7th ed.)*. Thomson Higher Education, Belmont, CA, USA.

Wasser, S.K., J.L. Keim, M.L. Taper and S.R. Lele. 2011. *The influence of wolf predation, habitat loss, and human activity on caribou and moose in the Alberta oil sands*. Frontiers in Ecology and the Environment 9: 546-551.

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37. Page 425, SIR Response 200

CNRL indicates it will not meet a February 15th out date to protect pre-calving and calving caribou. Rather, CNRL indicates it will undertake operations in a manner consistent with the EPEA approval for Kirby South. The EPEA approval has an out date of March 1st. CNRL indicates in its EIA and SIR1 responses that the local caribou population is declining and expected to continue to decline. Consequently, mitigation

measures undertaken by CNRL and other operators in the area are not sufficient to reverse cumulative impacts to caribou.

a. **Given this, identify why CNRL has not undertaken to meet the recommended February 15th out date?**

b. **Given this, what new and/or adapted mitigation measures is CNRL proposing to undertake in response to the continued decline of local herds?**

c. **How is CNRL engaging with other local industry partners and government to address mitigation at broader scale?**

Response:

a. While woodland caribou in the Cold Lake Caribou Range herd (and most herds in Alberta) are in a state of decline and calf recruitment rates are low, adult female caribou have high pregnancy and calving rates. This suggests that pregnancy and calving rates are not responsible for poor calf recruitment (ASRD and ACA 2010). In addition, the available evidence suggests that stress in the third trimester does not affect calf production rates (ASRD and ACA 2010; McLoughlin et al. 2003, Wittmer et al. 2005) and there has been no causal link to calf survival in the first months of life to the amount of disturbance within a range. Rather, the evidence is clear that predation is the primary cause of calf mortality during the first four weeks of life (ASRD and ACA 2010). As well, the caribou calving season in northern Alberta occurs in May and early June (Stuart-Smith et al. 1997), with most calves born in the first two weeks of May (ASRD and ACA 2010).

   Canadian Natural agrees that it has a role in the shared responsibility of caribou conservation and is committed to actions to manage Project impacts to caribou in the Cold Lake Caribou Range, as described in the Wildlife Assessment (refer to the responses to part b, the response to SIR 42d and Volume 5, Section 1.6 of the December 2011 Application [Canadian Natural 2011]) and the response to Round 1 SIR 200) However, changing the deadline for tree clearing activities from the approved March 1 date in EPEA Approval 237382-00-00 to February 15 is not justified considering the following:

   - There is no evidence that the earlier date would provide tangible benefits for woodland caribou conservation.
   - Information on the causes of caribou population declines has not changed since Approval 237382-00-00 was issued in August 2010.
   - To account for the combined migratory birds nesting and caribou calving period, clearing is restricted for 5 and half months annually (March 1 to August 15).

Furthermore the ideal window for conducting tree clearing activities is already very limited (i.e., during winter frozen ground conditions).

b. In response to the continued decline of local caribou herds, new mitigation Canadian Natural will undertake is caribou habitat restoration within the Project Area (i.e., the Kirby oil sands leases) on Canadian Natural's existing oil sands related clearings (e.g., seismic lines) that may no longer be required for Project activities (discussed in Volume 5, Section 4.5.1, in the responses to Round 1 SIRs 199a. 200b, 204, 205 and 254d and further explained in the response to Round 2 SIR 42e.

   Prior to initiating Project clearing activities each year, Canadian Natural will review its planned activities and proposed mitigation with the local ESRD office as part of the Caribou Protection Plan review and approval process.

c. Canadian Natural is in the process of initiating discussions with ESRD and other oil sands operators about joint caribou recovery options for the Cold Lake Caribou Range. In addition, in Volume 5, Section 1.7.4 Canadian Natural identified its participation in the Ecological Monitoring Committee for the Lower Athabasca of the Regional Terrestrial Monitoring Joint Working Group. The committee's work is facilitated through the Alberta Biodiversity Monitoring Institute, with membership from ESRD, industry, and Environment Canada. The committee is in the process of developing work plans for applied research to support regional level caribou recovery efforts.

References:

ASRD and ACA (Alberta Sustainable Resource Development and Alberta Conservation Association). 2010. *Status of the Woodland Caribou (Rangifer tarandus caribou) in Alberta: Update 2010*. Alberta Sustainable Resource Development. Wildlife Status Report No. 30 (Update 2010). Edmonton, AB. 88 pp.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Volumes 1 to 6.* Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

McLoughlin, P.D., E. Dzus, B. Wynes and S. Boutin. 2003. *Declines in populations of woodland caribou*. Journal of Wildlife Management 67(4):755-761.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. *Woodland Caribou Relative to Landscape Patterns in Northeastern Alberta*. Journal of Wildlife Management. 61: 622 633.

Wittmer, H.U., B.N. McLellan, D.R. Seip, J.A. Young, T.A. Kinley, G.S. Watts and D. Hamilton. 2005. *Population dynamics of the endangered mountain ecotype of woodland caribou (Rangifer tarandus caribou) in British Columbia, Canada*. Canadian Journal of Zoology 83:407-418.

38. Page 433-434, SIR Response 205

CNRL identifies that habitat restoration is an essential component of the caribou recovery strategy. CNRL indicates it will inventory historical disturbance features to identify locations where blocking access, reducing lines of sight and restoring habitat will be undertaken.

a. How long does CNRL anticipate the planning phase to take?

b. When does CNRL expect to undertake on-the-ground restoration of habitat to address linear disturbance?

Response:

a. As discussed in the response to Round 2 SIR 42e, assuming the Project is approved in late 2013, the inventory of opportunities for the Project would start in 2014 and planning would occur over 2014 and 2015. Canadian Natural will work with ESRD to confirm planning is consistent with the expected priorities of range planning for the Cold Lake Caribou Range.

b. Canadian Natural is targeting 2016 to begin the ground restoration of habitat to address linear disturbance.

39. Page 435, SIR Response 206

a. Response b. Updated Figure 4. The question refers to the lack of surveys in the east central portion of the lease and the southwestern portion of the lease. Based on the figure presented, it appears the southwestern portion of the lease is still missing track survey data. CNRL indicates additional surveys are to be undertaken in the 2012/2013 season. Provide a map of the existing survey locations overlain with the proposed additional survey transects. Ensure there is adequate geographical coverage of the missing areas and some overlap to

provide year-to-year context. Provide a proposed schedule for data collection, analyses and presentation of the updated results and impact assessment.

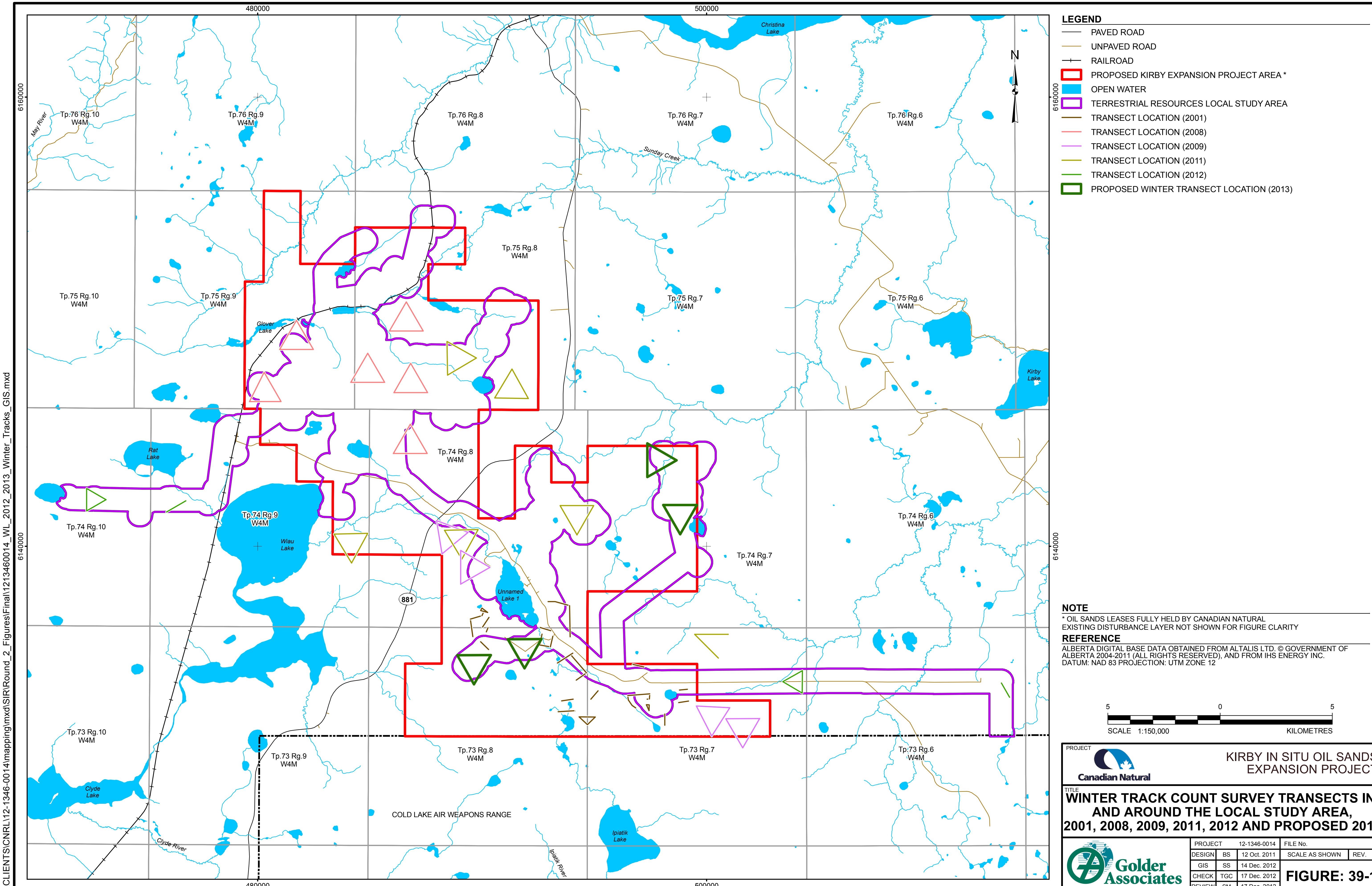
b. **ESRD understands that results of additional bat and bird surveys will be presented in memo format in October 2012. Please ensure these data, the updated analyses, and updated impact assessments are also presented in the SIR2 Response.**

Response:

a. Canadian Natural has proposed the additional winter track survey locations shown in Figure 39-1 to meet ESRD's request. The additional planned transects provide excellent coverage of the southwestern and east-central portions of the lease and, more importantly, the LSA where there is the highest potential for immediate environmental impacts from the Project to occur. However, it is important to note that it is not necessary to completely cover the LSA with every wildlife survey, as wildlife are mobile and the areas in the vicinity of the proposed Project are not unique habitat. Rather, the emphasis of wildlife surveys is to determine the presence and relative abundance of wildlife species in the ecosite phases and wetlands types present in the LSA. Baseline wildlife surveys conducted to date have successfully accomplished this goal. The surveys requested by ESRD are currently planned for completion in January or early February of 2013, pending appropriate weather conditions. The proposed winter tracking transect locations shown on Figure 39-1 are preliminary based on available mapping information; actual survey locations may need to be modified in the field based on access considerations. The results of the additional survey work will be provided to ESRD within two months of completion of the surveys.

b. An updated Wildlife Supplemental Baseline Report that includes the additional data collected in 2012 is provided as Appendix 39-1.

   The impact assessment was conducted with a suite of qualitative and quantitative tools, including expert knowledge, quantitative modeling and professional judgment. Data collected during bird and bat surveys conducted in 2012 were supportive of and consistent with the existing body of ecological knowledge that was the qualitative and quantitative foundation of the assessment of Project effects. Therefore, the additional baseline information collected would not change the wildlife analyses nor the results of the EIA.


LEGEND
PAVED ROAD
UNPAVED ROAD
RAILROAD
PROPOSED KIRBY EXPANSION PROJECT AREA *
OPEN WATER
TERRESTRIAL RESOURCES LOCAL STUDY AREA
TRANSECT LOCATION (2001)
TRANSECT LOCATION (2008)
TRANSECT LOCATION (2009)
TRANSECT LOCATION (2011)
TRANSECT LOCATION (2012)
PROPOSED WINTER TRANSECT LOCATION (2013)
NOTE
* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY
REFERENCE
ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), AND FROM IHS ENERGY INC.
DATUM: NAD 83 PROJECTION: UTM ZONE 12
5 0 5
SCALE 1:150,000 KILOMETRES
N
480000
500000
6160000
6140000
Tp.76 Rg.10 W4M
Tp.76 Rg.9 W4M
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Tp.74 Rg.8 W4M
Tp.74 Rg.7 W4M
Tp.74 Rg.6 W4M
Tp.73 Rg.10 W4M
Tp.73 Rg.9 W4M
Tp.73 Rg.8 W4M
Tp.73 Rg.7 W4M
Tp.73 Rg.6 W4M
May River
Christina Lake
Sunday Creek
Glover Lake
Rat Lake
Wiau Lake
Kirby Lake
Unnamed Lake 1
881
Clyde Lake
Clyde River
Ipiatik Lake
Ipiatik River
COLD LAKE AIR WEAPONS RANGE
PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT
TITLE
WINTER TRACK COUNT SURVEY TRANSECTS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011, 2012 AND PROPOSED 2013
Golder Associates
PROJECT 12-1346-0014
FILE No.
DESIGN BS 12 Oct. 2011
SCALE AS SHOWN
REV. 0
GIS SS 14 Dec. 2012
CHECK TGC 17 Dec. 2012
REVIEW SM 17 Dec. 2012
FIGURE: 39-1
I:\CLIENTS\CNRL\12-1346-0014\mapping\mxd\SIR\Round_2_Figures\Final\1213460014_WL_2012_2013_Winter_Tracks_GIS.mxd

40. Page 507, SIR Response 249

CNRL indicates that the reduction in groundwater discharge to Birch Creek, Sunday Creek and an unnamed tributary are between 0% and 4% with a maximum reduction in the upper reach of Birch Creek of 4.1%.

a. What are the confidence limits associated with these predictions?

Response:

a. As described in Volume 4, Appendix 4-4 of the December 2011 Application (Canadian Natural 2011), as with any effort in predicting future outcomes, there is a degree of uncertainty. The prediction uncertainty associated with the calibrated parameter values used in the numerical model of groundwater flow, was assessed using the Calibration Constrained Subspace Monte Carlo analysis. Predicted changes in groundwater discharge to surface waterbodies (e.g., Birch Creek and Sunday Creek) were estimated as part of this effort. The analysis indicates that the uncertainty associated with the calibrated parameter values results in a small prediction uncertainty with respect to groundwater discharge to surface waterbodies. Therefore, the level of confidence in predictions is interpreted to be high (Volume 4, Appendix 4-4; Table 3 and Figures 204 to 210).

Confidence limits associated with the predicted maximum reduction in groundwater discharge to surface waterbodies can be estimated based on the range of predicted outcomes in the Monte Carlo realizations. The maximum predicted change in flux at each of the considered surface water locations was presented in Table 3 (Volume 4, Appendix 4-4). For further clarification an updated version of Table 3 (Volume 4, Appendix 4-4) with units converted to L/s and the names of the hydrogeology observation points and corresponding hydrology assessment nodes is provided in Table 40-1. The table shows that individual realization values deviate slightly from the calibrated solution.

Table 40-1 Monte Carlo Results Summary Table - Application Case Maximum Predicted Flux Change

Observation Point	Assessment Node	Figure Number	Calibrated Solution (January 1, 2000) Estimated Base Flow [L/s]	Maximum Predicted Flux Change [L/s]				
				Calibrated Solution	Minimum from Monte Carlo Realizations	Mean from Monte Carlo Realizations	Maximum from Monte Carlo Realizations	Standard Deviation from Monte Carlo Realizations
Birch Creek - BC1	BC-N1	204	-18.0	2.15	1.91	2.13	2.27	0.07
Birch Creek - BC2	BC-N2	205	-72.3	3.72	3.31	3.67	3.92	0.12
Sand River - S3	SC-N1	206	3.8	0.19	0.17	0.19	0.20	0.01
Sand River - S4	SC-N2	207	-6.6	0.36	0.33	0.35	0.37	0.01
Sand River - S5	SC-N3	208	-47.3	3.10	2.85	3.08	3.19	0.08
Unnamed Creek - UNT6	UNT-N1	209	-25.3	0.42	0.37	0.41	0.44	0.02
Wiau Lake - WL8	WL-N1	210	-38.1	0.74	0.65	0.73	0.79	0.03

Note: Volume 4, Appendix 4-4, Table 3 revised; 1) Added reference to Volume 4, Table 2.4-2 assessment nodes 2) converted m^3/d to L/s for unit consistency between tables.

Reference:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project, Application for Approval, Volumes 1 to 6.* Submitted to the Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

41. Page 512, SIR Response 252

CNRL indicates the environmental consequence was predicted to be high for caribou in the PDC case, noting that caribou are currently declining and at risk of extirpation in the RSA.

a. The CNRL Kirby Expansion Project is associated with two other projects, the Enerplus Kirby Project and the CNRL Kirby Project. Describe the impact predictions related to caribou presented in each of the other project applications. Describe the level of confidence attributed to those predictions. Compare them to the predictions presented in the Kirby Expansion. If they have changed, discuss why.

b. Are there implications to CNRL's confidence in predictions associated with other listed species?

Response:

a. In general, the Planned Development Case for projects that are proposed at different points in time cannot be directly compared, as they necessarily incorporate the best available information on developments that are existing, approved and planned (i.e., those developments that have been publicly disclosed up to six months prior to the submission of the EIA), and this information may differ substantially over time. The EIA for the Canadian Natural Kirby Project was submitted in September of 2007, while the EIA for the Canadian Natural Kirby Expansion Project was submitted in December of 2011. Further, ESRD (Alberta Environment at the time) did not require Enerplus to complete an EIA for their September 2008 Kirby Project application so a PDC is not available for that project.

   The EIAs for the Canadian Natural Kirby Project and the Canadian Natural Kirby Expansion Project were in agreement in assessing the environmental consequence for caribou abundance as high in the PDC. Population data at the time of both EIAs suggest that the herds in the RSA are declining to extirpation. The confidence in these predictions is high given baseline conditions, current trends and past management activities. However, as stated in Volume 5, Section 4.5.1 of the December 2011 Application, new landscape-scale strategies recommended by the Athabasca Landscape Team (ALT 2009) and further examined by Schneider et al. (2010) may conserve woodland caribou within the RSA. These strategies are considered in the recently released Caribou Policy for Alberta (Government of Alberta 2011) and the Environment Canada (2012) Recovery Strategy for the Woodland Caribou; however, a plan and schedule for implementation are yet to be developed. Information about Canadian Natural's caribou habitat restoration efforts are discussed in Round 2 SIR44e.

b. Canadian Natural's confidence in predictions associated with all species, listed and otherwise, has been carefully considered in the environmental assessment process. No information is currently available that would result in implications to the stated confidence in predictions for any wildlife KIR.

References:

ALT (Athabasca Landscape Team). 2009. *Athabasca Caribou Landscape Management Options Report*. 115 pp.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Volumes 1 to 6. Submitted to Alberta Environment and Water, and the Energy Resources Conservation Board. December 2011.

Environment Canada. 2012. *Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada*. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. xi + 138pp.

Government of Alberta. 2011. *A Woodland Caribou Policy for Alberta*. Available online: http://www.srd.alberta.ca/FishWildlife/WildlifeManagement/CaribouManagement/documents/WoodlandCaribouPolicy-Alberta-Jun2011.pdf

Schneider, R.R., G. Hauer, W.L. Adamowicz and S. Boutin. 2010. *Triage for conserving populations of threatened species: The case of woodland caribou in Alberta*. Biological Conservation 143(7): 1603-1611.

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42. Page 517, SIR Response 254

CNRL was requested for information required to understand how the proposed Project will affect undisturbed boreal caribou habitat. The federal Draft Recovery Strategy was cited and contextual information provided in the request. The recovery strategy is no longer draft and was posted to the SARA website on October 5, 2012.

In the original question, CNRL was requested to identify undisturbed [disturbed] habitat including existing exploration footprint (request a) and expected exploration footprint (request b). This information was not clearly provided. It is important to understand how implementation and operation of the proposed project will influence boreal caribou recovery efforts. Of particular importance is understanding how CNRL's proposed project will influence the remaining 15% of undisturbed boreal caribou habitat and how the project may affect habitat recovery efforts to meet the goal of maintenance "of a perpetual state of a minimum 65% of the area as undisturbed habitat" (Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada). CNRL operates other in situ projects in northeast Alberta and works closely with other operators in the project area. Given the combined experience, it is unreasonable for CNRL to suggest that future exploration footprint cannot be estimated. In order to clearly describe the influence of the Project on boreal caribou habitat, provide the following:

a. A description and map of a modified local study area (LSA) the boundary of which circumscribes all project-related disturbance including past and expected exploration and monitoring (4D seismic and/or monitoring wells) footprint. Identify all disturbance and draw the 500 metre buffer.

b. Summary tables depicting/describing the baseline disturbance in the revised LSA including existing exploration footprint.

c. Map and summary tables depicting/describing the project disturbance in the revised LSA including expected/estimated exploration and monitoring (4D seismic and/or monitoring wells) footprint. Identify all disturbance and draw the 500 metre buffer. Highlight areas of project-related reduction of caribou habitat. Provide a discussion.

d. A quantitative assessment and discussion of any reduction in the remaining 15% of undisturbed Cold Lake herd caribou habitat.

e. A quantitative assessment of local habitat restoration opportunities within the project lease boundary to offset habitat loss. Identify a greater than 1:1 ratio of restoration to support efforts to increase caribou habitat toward the 65% perpetual habitat maintenance goal. Provide a map and discussion.

f. Within the Cold Lake woodland caribou herd range, a quantitative assessment of habitat restoration opportunities associated with sites under CNRL's purview. Identify a greater than 1:1 ratio of restoration to support efforts to increase caribou habitat toward the 65% perpetual habitat maintenance goal. Provide a map and discussion.

g. Describe a plan to undertake this restoration including the rate and timeline for restoration, monitoring and reporting.

Response:

a. See the response to Round 2 SIR Response 35.

b. See the response to Round 2 SIR Response 35.

c. See the response to Round 2 SIR Response 35.

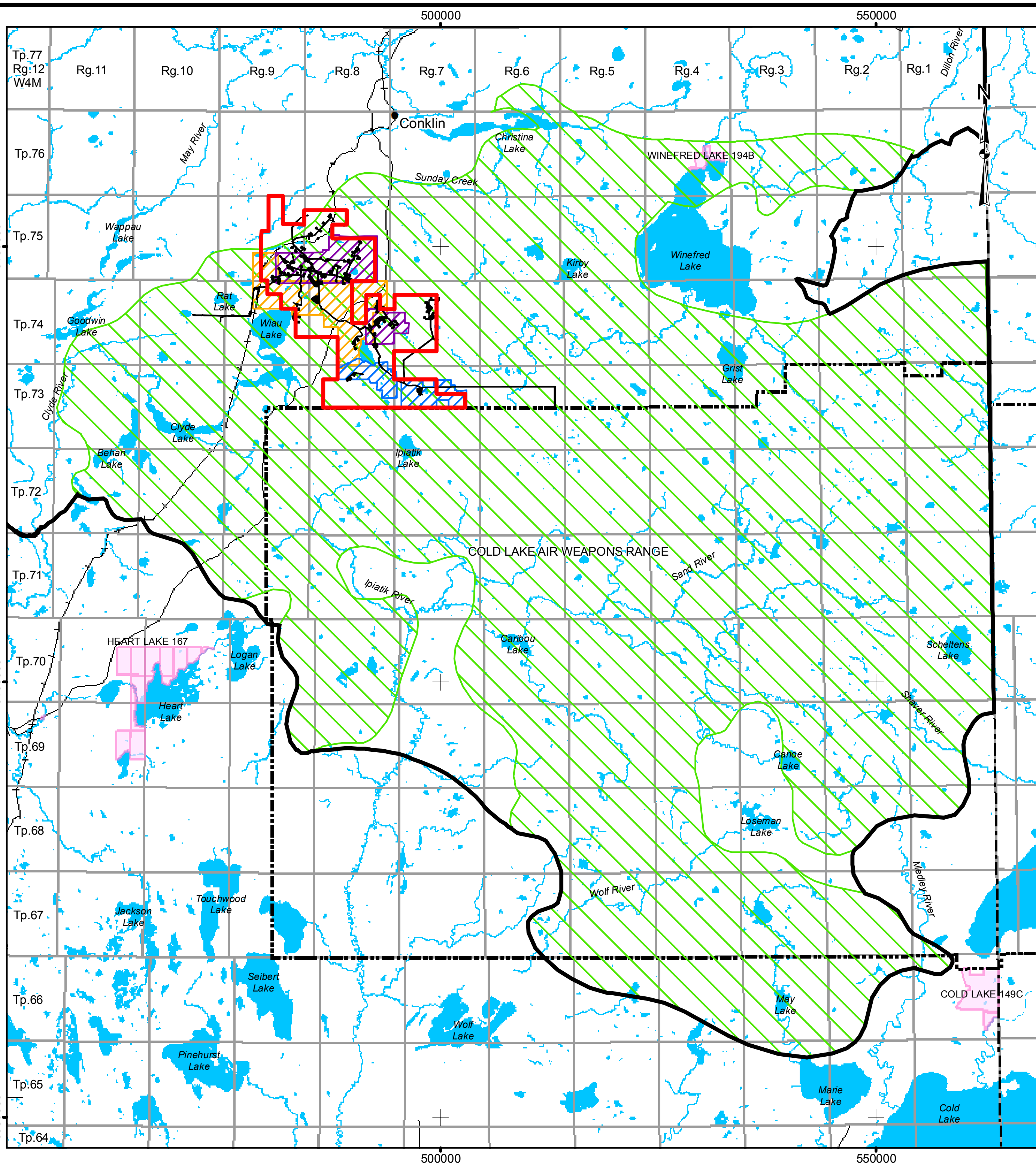
d. In the response to Round 1 SIR 254a Canadian Natural calculated that, based on the criteria used by Environment Canada to define disturbed habitat (i.e., the effects of forest fire that has occurred in the past 40 years and anthropogenic or human-caused disturbance to the landscape that could be visually identified from Landsat imagery at a scale of 1:50,000, plus a 500 m buffer), there will be a further reduction in undisturbed habitat by 113 ha as a result of the construction and operations of the Project. This calculation takes into account existing baseline disturbance (with a 500 m buffer). In the Recovery Strategy for the Woodland Caribou (Environment Canada 2012) it is estimated that 15% of the Cold Lake Caribou Range is undisturbed habitat.

The amount of undisturbed habitat in the 672,422 ha Cold Lake Caribou Range size is 100,863 ha. The 113 ha reduction in undisturbed habitat as a result of the Project (equal to 0.11% of the existing undisturbed habitat area) represents a change of 0.02% in undisturbed habitat in the entire Cold Lake Caribou Range (i.e., will result in 14.98% undisturbed habitat within the total area of the range).

If existing seismic clearing related to the Project and to the approved Kirby South 2010 project (Figure 42-1), plus a 500 m buffer, is included with the Project footprint, and not the Baseline Case, then the total Project plus existing seismic footprint will result in a 653 ha (0.65%) decrease in undisturbed habitat in the Cold Lake Caribou Range, which represents a change of 0.11% in existing undisturbed habitat (i.e., will result in 14.89% undisturbed habitat within the total area of the range).

Consideration of Canadian Natural's proposed seismic activity for winter 2012-2013 could result in an additional reduction in undisturbed habitat of 158 ha (0.16%), which represents an additional 0.02% change in undisturbed habitat (i.e., would result in 14.86% undisturbed habitat within the total Cold Lake Caribou Range area).

These estimates are conservative because the reduction in undisturbed habitat area from the Project plus existing seismic footprint includes 55 ha of previously undisturbed habitat associated with the existing seismic for the approved Kirby South 2010. Furthermore Canadian Natural also considers the application of a 500 m buffer to linear anthropogenic disturbances to result in an overly conservative estimate of disturbance footprint within a caribou range.



LEGEND

- COMMUNITY
- PAVED ROAD
- RAILROAD
- INDIAN RESERVE
- OPEN WATER
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- COLD LAKE CARIBOU RANGE
- AREA OF EXISTING PROJECT SEISMIC
- AREA OF EXISTING KIRBY SOUTH 2010 SEISMIC
- AREA OF PLANNED 2013 PROJECT SEISMIC
- PROPOSED KIRBY EXPANSION PROJECT FOOTPRINT

25 0 25

SCALE 1:650,000 KILOMETRES

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), IHS ENERGY INC .CARIBOU RANGES OBTAINED FROM ACC (ALBERTA CARIBOU COMMITTEE) © 2010 ASRD. SEISMIC LINE DATA OBTAINED FROM CLIENT (2012).
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

EXISTING AND PROPOSED PROJECT SEISMIC WITHIN THE COLD LAKE CARIBOU RANGE

Canadian Natural

PROJECT		12-1346-0014	FILE No.
DESIGN	TC	28 Nov. 2012	SCALE AS SHOWN REV. 0
GIS	SS	14 Dec. 2012	
CHECK	TGC	17 Dec. 2012	FIGURE: 42-1
REVIEW	SM	17 Dec. 2012	

I:\CLIENTS\CNRL\12-1346-0014\mapping\mxd\SIR\Round_2_Figures\Final\1213460014_WL_004_GIS_Caribou_Range.mxd

e. The *Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou)* (Environment Canada 2012) was released by the federal government in October 2012. The strategy requires that range plans be completed by the jurisdiction responsible for land and natural resources management within three to five years of the posting of the recovery strategy. In the case of the Cold Lake Caribou Range where the Project is proposed, the responsible jurisdiction is ESRD. Range plans are documents that outline how a given range will be managed to ensure that critical habitat is protected. Canadian Natural recognizes the importance of actions to offset Project impacts in support of caribou conservation in the Cold Lake Caribou Range and to establish clear targets and timelines for such efforts. As the Cold Lake Caribou Range is larger than the Kirby Expansion Project Area, the development and implementation of the range plan will occur at a more regional level than the Project Area and will involve a collaborative effort between government, industry, Aboriginal communities and other stakeholders. Canadian Natural agrees that it has a role in the shared responsibility of caribou conservation and is committed to involvement in the range-level planning and subsequent implementation that will be forthcoming for the Cold Lake Caribou Range. This was discussed in the response to Round 1 SIR 200b. However, Canadian Natural believes it would not be appropriate to undertake range-level habitat restoration efforts and to identify targets and specific timelines independent of the range planning process led by ESRD, particularly since Canadian Natural's efforts to offset Project impacts needs to be consistent with that planning and they would affect other surface rights holders within and adjacent to the Project Area. Canadian Natural is in the process of initiating discussions with ESRD and other oil sands operators about caribou recovery options.

As discussed in Volume 5, Section 4.5.1 of the December 2011 Application (Canadian Natural 2011) and in the responses to Round 1 SIRs 199a. 200b, 204, 205 and 254d, Canadian Natural is committed to reviewing Project development plans and access needs in relation to the presence of existing linear clearings and is committed to identifying opportunities for habitat restoration to offset Project impacts and benefit caribou. Canadian Natural's intent is to focus this effort within the Project Area (i.e., the Kirby oil sands leases) on Canadian Natural's existing oil sands related clearings (e.g., seismic lines) that may no longer be required for Project activities. Starting in 2013 Canadian Natural will initiate an inventory of habitat restoration opportunities for Kirby South 2010 as part of the approved Kirby South 2010 Wildlife Mitigation and Monitoring Plan. Assuming the Kirby Expansion Project is approved in late 2013, the inventory of opportunities for the Project would start in 2014, and planning would occur over 2014 and 2015. Based on this inventory schedule, habitat restoration activities to offset Project impacts would begin in 2016.

Specific locations for habitat restoration cannot be identified at this time. During the 2014 to 2015 inventory for the Project, Canadian Natural will work with ESRD to set clear targets, timelines and monitoring/reporting requirements for this effort and to confirm it is consistent with the expected priorities of the Cold Lake Caribou Range plan.

This process will also be informed by, and is expected to be supportive of, the biodiversity management framework and regional landscape management plan, which are to be developed in 2013 for the Lower Athabasca Region as part of the Lower Athabasca Regional Plan (Government of Alberta 2012).

The primary intent of habitat restoration will be to restore functional caribou habitat by reducing hunter and recreational all terrain vehicle/snowmobile user access, impeding the movements and hunting efficiency of predators (e.g., wolves), and discouraging the use of caribou habitat by moose and deer (i.e., alternate prey species that attract wolves). Measures that could be used to achieve this include the following:

- Access management - earthen mounds or berms, boulders, slash piles, slash rollback and signage.
- Line-of-sight control - planting of trees and shrubs that do not promote deer or moose browse opportunities (e.g., conifers), staking, mounding and planting, or other re-vegetation measures (e.g., blading an upland site to promote aspen suckering).

Canadian Natural will rely on experience gained since 2008 with similar work implemented as part of the Habitat Enhancement Plan (HEP) at Canadian Natural's PAW project to inform caribou habitat restoration work at the Project Area. A combination of measures have been implemented at PAW to block access, reduce line of site and restore habitat, including: placement of slash roll back, creation of earthen mounds, and planting of trees and shrubs.

The HEP process at PAW involved an inventory of the current vegetation regeneration status of disturbed areas within the 12 whole or partial townships that make up the PAW area using aerial imagery and ground truthing. The results of this inventory were then considered in the context of Canadian Natural's 10 Year Development Plan so that candidate treatment sites for the HEP could be prioritized away from future planned development areas. One abandoned non-linear disturbance and 4,900 m of linear disturbances were treated with mounding by excavator and/or slash rollback to control access, for a total of 33,400 m^2 of treated area. In addition, upland sites were scraped with the excavator rake to form small depressions and mounds as microsites to aid in tree establishment. The mounding target density was generally about 1,600 mounds per hectare. Tree planting was then conducted in the spring of 2011 and 2012, and monitoring plots were established and surveyed after the first growing season to determine regeneration success. Sites will be visited again after the third growing season, at which time seedlings should be growing based on site conditions rather than relying on fertilizer that was in the nursery plugs. This will allow for a better estimation of how the seedlings will perform over time. In general, monitoring conducted so far has shown that seedlings have been growing as expected or better than expected.

f. Canadian Natural's first priority for caribou habitat restoration to offset Project impacts is to undertake work within the Project Area, as discussed in the response to part e. Canadian Natural believes it would not be appropriate to undertake range-level habitat restoration efforts, and to identify targets and specific timelines, including on lands under Canadian Natural purview outside of the Project Area, independent of the range planning process led by ESRD. Canadian Natural is in the process of initiating discussions with ESRD and other oil sands operators about caribou recovery options.

g. See the response to part e.

References:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Submitted to Energy Resource Conservation Board and Alberta Environment and Water. December 2011.

Canadian Natural. 2012*. Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

Environment Canada. 2012. *Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada*. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. xi + 138pp.

Government of Alberta, 2012. *Lower Athabasca Regional Plan, 2012-2022*. Edmonton, AB. 98 pp.

43. Canadian Natural notes that there was a discrepancy in the numbering of the final Supplemental Information Request 2 document and that no request is associated with Round 2 SIR 43.

44. Appendix U-1

CNRL reports on benthic field studies carried out in fall 2011.

a. **It is indicated that five samples were collected at each of the sample sites. However, data are reported without confidence limits. Please provide this and the associated discussion.**

b. **There is a single erosional sample site. Provide a discussion of what conclusions might be drawn from a single sample site. Describe the limitation of data from a single sample site. Will CNRL undertake additional sampling of erosional sites and of this site through time? If not, provide a rationale.**

c. **Data were collected at three waterbody sites. The conclusion presented in the summary on page 15, Section 4, is that *Each of the three waterbodies sampled had unique habitat that was reflected in different benthic communities present in terms of density, richness and community composition*. However, these sites are not described in a context of what might be expected or why they were considered to each have unique habitat. Provide supporting discussion for the conclusion. Further, discuss what might be concluded from a single sampling event at each of three waterbodies. Discuss the limitations of the study design and data collected.**

d. **CNRL provides a site by site description of the results of field sampling. However, no conclusions are provided other than a brief summary paragraph that does not provide supporting documentation for the conclusions drawn.**

   i. **Place the results into the regional and historical context / dataset?**

   ii. **Provide a Conclusions section to the document. Ensure conclusions are supported.**

   iii. **Discuss how well the study objectives were met (Page 1, Section 1.1 – *The objectives of this baseline study were to characterize baseline invertebrate communities in waterbodies and watercourses in the Project Area, and to provide data and information necessary to support the assessment of potential effects of the Project on fish and fish habitat*).**

   iv. **Discuss how well the sampling design met the first part of the stated objective (characterize benthic invertebrate communities). Identify areas where the objective was met and where it was not. Describe adjustments to the sampling design to might better meet this portion of the objective.**

v. **Discuss how the second portion of the objective was met (data and information to support the assessment of potential effects). Describe clearly how the data were used in the assessment of potential effects. I**

e. **Part of the intent of baseline data collection is to provide a reference point against which to compare future sampling. Provide a discussion of the scope of CNRL's benthic sampling in this context. If the data collected are insufficient to provide a reference point, clearly identify future work to be undertaken to augment these data. Describe the proposed sampling design.**

Response:

a. The full data set (i.e., detailed data for each of the five samples from each site) is reported in Appendix A of Appendix U-1 to the Round 1 SIRs (Canadian Natural 2012), and data for benthic community summary variables (total density and richness) are summarized as the mean and standard error in Tables 3 and 4 of Appendix U-1. The standard error provides an estimate of within-station variation and is more commonly reported in benthic studies than confidence limits. The observed within-station variation indicated by the standard error values in Tables 3 and 4 were within the range of variation frequently observed in waterbodies and watercourses in the oil sands region.

b. The objective of the 2011 baseline study was to collect benthic invertebrate community data for waterbodies and watercourses for which previous baseline data were not available. As described in Appendix U-1, Section 1.3 the 2011 benthic invertebrate baseline surveys were conducted in the Aquatics LSA. Therefore the data reported in Appendix U-1 do not represent the only baseline information available for benthic invertebrates for this Project. The benthic invertebrate baseline section of the Aquatic Ecology Baseline Report (provided on CD with the December 2011 Application [Canadian Natural 2011]) summarizes available data in the LSA and RSA delineated for the Project, from benthic studies spanning 40 years. These studies include six studies completed since 2000, and Regional Aquatics Monitoring Program surveys from 2003 to 2010. Thus, while limited information can be obtained from data collected at a single site, baseline data for the assessment were available for 13 waterbody sites and 17 watercourse sites in the RSA, and for 3 waterbody sites and 13 watercourse sites in the LSA. Watercourses in the LSA are predominantly depositional; therefore, availability of data for a single erosional site reflects the relative proportions of depositional and erosional habitat types in this area. In consideration of the information presented above, Canadian Natural will not be undertaking additional erosional site sampling.

c. During aquatic baseline studies, considerable habitat variation is expected within major habitat types (e.g., depositional) reflecting physical features of the sites sampled, such as water depth, current velocity, sediment characteristics and aquatic plant growth. This variation in habitat contributes to the variation in benthic invertebrate community characteristics, which in this case resulted in some sites being characterized as unique relative to others.

As noted in the response to part b, Appendix U-1 describes a subset of the available baseline data. All available baseline benthic community data in the Project LSA and RSA are provided in the Aquatic Ecology Baseline Report and Appendix U-1 combined.

d. As noted in the response to part b, Appendix U-1 describes a subset of a larger available local and regional baseline data set for benthic invertebrates. Given the data available, Canadian Natural has met the objective of characterizing the benthic invertebrate communities in waterbodies and watercourses in the Project Area.

   The purpose of baseline studies is to present and describe available baseline data and conditions. Baseline studies are not intended for "drawing conclusions", but simply provide data characteristic of current conditions in an area. In lieu of conclusions, Canadian Natural has provided a summary (Appendix U-1, Section 4) describing the general features of the data collected. The baseline benthic invertebrate data support the assessment, in that these data are used as a basis for predicting changes to benthic invertebrate communities from the Project if physical/chemical changes are predicted in the aquatic environment. However, as described in Volume 4, Section 4.4.2.2, the mitigation planned for the Project will result in minor and temporary physical disturbances to surface waters (e.g., stream crossings), will assist with re-establishment of benthic invertebrate communities, and will result in water quality changes that are predicted to be negligible; therefore, the residual effects to benthic invertebrate communities are predicted to be of negligible environmental consequence. Based on mitigations incorporated for the Project as well as the baseline habitat conditions in the affected habitats (including changes to fish habitat that would result from changes to benthic invertebrate communities), the potential effects on fish habitat are assessed as negligible (Volume 4, Section 4). In consideration of this information, Canadian Natural has met the second portion of the study objective (data and information to support the assessment of potential effects).

e. As noted in the response to part b, Appendix U-1 describes a subset of a larger available local and regional baseline data set for benthic invertebrates. Considering all available local and regional data, the amount of benthic invertebrate baseline data available for the Project provides a sufficient reference point against which to compare future sampling results and is typical for an in situ oil sands EIA. Canadian Natural does not believe additional benthic invertebrate baseline sampling is warranted at this time.

References:

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Submitted to Energy Resource Conservation Board and Alberta Environment and Water. December 2011.

Canadian Natural. 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project.* Supplemental Information. Submitted to Energy Resources Conservation Board, and Alberta Environment and Sustainable Resource Development. August 2012.

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45. SIR 88 response a, Page 197

In the third last line of the third paragraph, the units after 10.9 should be Sm^3 rather than t CO2E.

Response:

The third last line of the third paragraph should read "This equates to 10.9 Sm^3/bbl steam."

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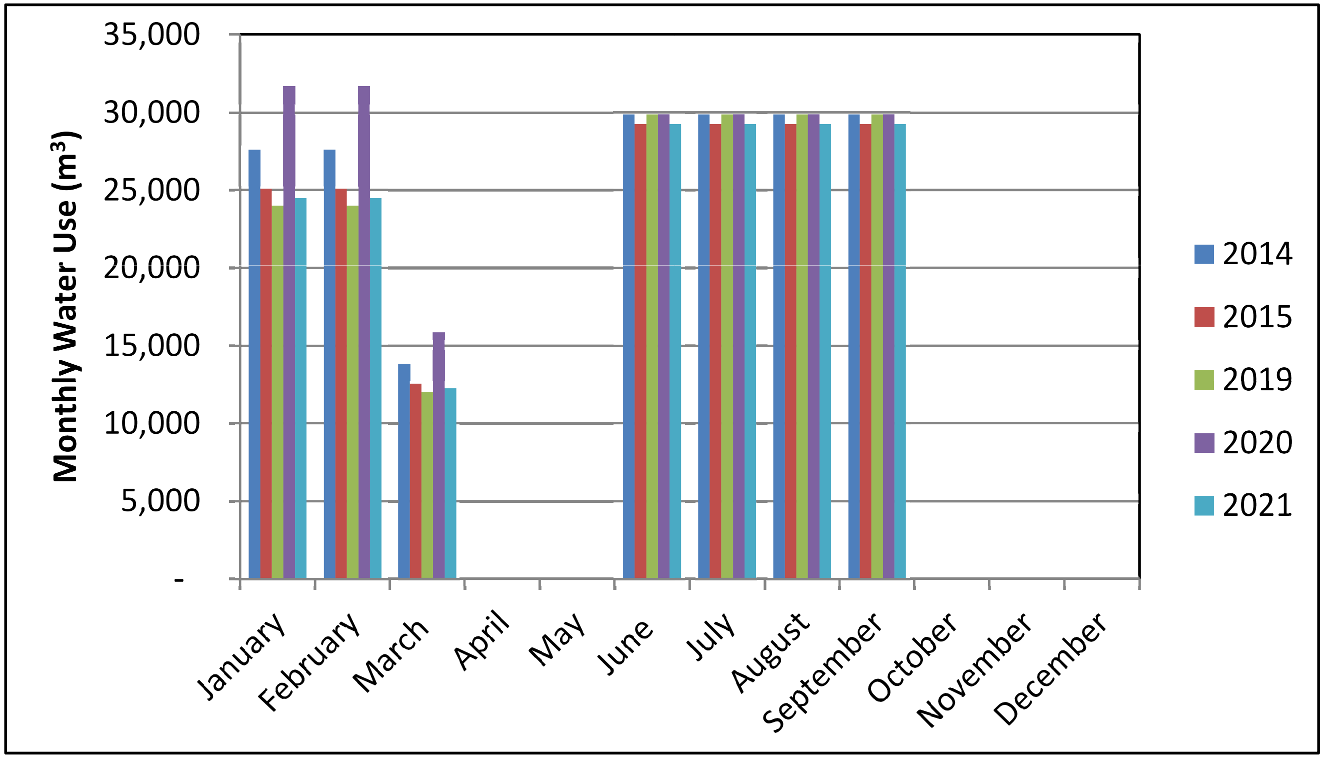
46. Page 342, Figure 149-3

The colours on the bars do not match those in the legend. Confirm that the bars are in order of the years.

Response:

The bars in the graphs shown in Figure 46-1 are in order of the years, from 2014 on the left to 2021 on the right. The colours in the legend matched the bar colours in the electronic submissions of the August 2012 Supplemental Information; however, there was a problem with the colours in the printed version of the submission. A copy of Figure 149-3 has been re-included as Figure 46-1 for reference.

L:\2012\1346\12-1346-0014\SIR\5700\Report_A\Fig46-1_12134600145700A008_MonthlyWater.dwg Dec 13, 2012 - 9:03am



PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

MONTHLY SURFACE WATER USE

Canadian Natural

PROJECT	12.1346.0014.5700		FILE No.	12134600145700A008
DESIGN	TGC	13 Aug. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	24 Aug. 2012	**FIGURE: 46-1**	
CHECK	TGC	27 Aug. 2012		
REVIEW	JG	27 Aug. 2012		

ABBREVIATIONS

%	Percent
<	Less than
>	Greater than
°C	Degrees Celsius
µg/L	micrograms per litre
µm	micron or micrometre
4-D	Four dimensional
7Q10	Lowest 7-day consecutive flow that occurs, on average, once every 10 years
AAAQO	Alberta Ambient Air Quality Objectives
AQMF	Air Quality Management Framework
ASRD	Alberta Sustainable Resource Development
AVI	Alberta Vegetation Inventory
$CaCl_2$	Calcium Chloride
Canadian Natural	Canadian Natural Resources Limited
CCME	Canadian Council of Ministers of the Environment
Chard	Chard Métis Local #214
cm	Centimetre
CPF	Central Processing Facility
CSS	Cyclic Steam Stimulation
Devon	Devon Canada Corporation
DFO	Fisheries and Oceans Canada
DO	Dissolved Oxygen
DOC	Dissolved Organic Compound
e.g.	For example
EAP	Enhanced Approval Process
EC_{50}	Half Maximal Effective Concentration
EIA	Environmental Impact Assessment
EPEA	Environmental Protection and Enhancement Act
ERCB	Energy Resources Conservation Board
ESRD	Environment and Sustainable Resource Development
et al.	And others
g/kg	Grams per kilogram
GFR	Geophysical Field Report

Golder	Golder Associates Ltd.
GPS	Global Positioning System
ha	Hectare
HSI	Habitat Suitability Index
HSPF	Hydrological Simulation Program-Fortran
i.e.	That is
ID	Interim Directive
kg	Kilogram
kg/d	Kilograms/day
kg/ha	Kilograms per hectare
kg/m^3	Kilograms per cubic metre
Kh	Horizontal permeability
KIR	Key Indicator Resources
Kirby North	Kirby Oil Sands Project Phase 1
Kirby South	Kirby In Situ Oil Sands Project
km	Kilometre
km/hr	Kilometres per hour
km^2	Square kilometre
KN	Kirby North
KN1	Kirby North Phase 1
KN2	Kirby North Phase 2
kPa	Kilopascals
KS	Kirby South
KS1	Kirby South 2010
KS2	Kirby South Phase 2
L	Litre
L/s	Litres per second
LC_{50}	Lethal Concentration 50
LDAR	Leak Detection and Repair
LIDAR	Light Detection and Ranging
Local 2010	Athabasca Landing Métis Local #2010
LOEC	Lowest Observed Effect Concentration
LSA	Local Study Area
m	Metre

m^2	Square metres
m^3	Cubic metre
MATC	Maximum Acceptable Toxicant Concentration
mg/L	Milligrams per litre
mTVD	Metres True Vertical Depth
NB1	Zone 1 Northern Boreal
NB4	Zone 4 Northern Boreal
ng/L	Nanograms per litre
NOEC	No Observed Effect Concentration
PAH	Polycyclic Aromatic Hydrocarbons
PAI	Potential Acid Input
PAW	Primrose and Wolf Lake
PDA	Pre-Disturbance Assessment
PDC	Planned Development Case
pers. Comm.	Personal communications
RLCC	Regional Land Cover Classes
ROW	Rights of Way
RSA	Regional Study Area
RSF	Resource Selection Function
RSPF	Resource Selection Probability Function
SAGD	Steam Assisted Gravity Drainage
SCADA	Supervisory Control and Data Acquisition
SIL	Survey Intensity Level
SIR	Supplemental Information Request
Sm^3/bbl	Standard cubic metre per barrel
TDS	Total Dissolved Solids
The Project	Kirby In Situ Oil Sands Expansion Project
TOR	Terms of Reference
TRS	Total Reduced Sulphur
TSS	Total Suspended Solids
TUS	Traditional Use Study
U.S. EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

GLOSSARY

Abiotic Non-living factors that influence an ecosystem, such as climate, geology and soil characteristics.

Aboriginal Peoples The descendants of the original inhabitants of North America. The Canadian Constitution recognizes three groups of Aboriginal people — Indians, Métis and Inuit (*Constitution Act 1982*).

Acid Neutralizing Capacity (ANC) The equivalent capacity of a solution to neutralize strong acids. Acid Neutralizing Capacity can be calculated as the difference between non-marine base cations and strong anions. This is the principal variable used to quantify the acid-base status of surface waters. Acidification is often quantified by decreases in ANC, and susceptibility of surface waters to acidic deposition impacts is often evaluated on the basis of ANC.

Acid Pulse Acid pulse (or episodic acidification) refers to a rapid drop in pH in surface waters over a short period. It typically occurs in the spring, and may result from: (1) dilution of base cations in surface waters by large volumes of runoff from snowmelt; and/or (2) release of acids stored in the snowpack that originated from industrial emissions.

Acidification The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic processes. Acidification is exhibited as the lowering of pH.

Acute A stimulus severe enough to rapidly induce an effect; in aquatic toxicity tests, an effect observed in 96 hours or less is typically considered acute. When referring to aquatic toxicology or human health, an acute effect is not always measured in terms of lethality.

Admixing The dilution of topsoil with subsoil, spoil or waste material, with the result that topsoil quality is reduced. Admixing can result in adverse changes in topsoil texture, poor soil aggregation and structure, loss of organic matter and decrease in friability.

Adsorption The surface retention of solid, liquid or gas particles by a solid or a liquid.

Aeolian Sedimentary deposits arranged by wind, such as sand and other loose substrates in dunes.

Aggregate Referring to any granular material formed from a natural rock substance. It is usually further defined either by its source (e.g., primary, secondary, recycled), by its geology (e.g. limestone, granite, sand and gravel, etc.), by its grading (coarse or fine) or by its end use (e.g., concrete aggregate).

Airshed The geographic area requiring unified management to achieve air pollution control.

Alberta Ambient Air Quality Objective (AAAQO) Alberta Ambient Air Quality Objective levels are established for several air compounds under Section 14 of the Environmental Protection and Enhancement Act (EPEA). The AAAQOs form an integral part of the management of air quality in the province, and are used for reporting the state of the environment, establishing approval conditions, evaluating proposed facilities with air emissions, assessing compliance near major air emission sources and guiding monitoring programs.

Alberta Energy and Utilities Board (EUB) An independent, quasi-judicial agency of the Government of Alberta, the EUB was created in February 1995 by the amalgamation of the Energy Resources Conservation Board and the Public Utilities Board. The purpose of the EUB is to ensure that the discovery, development, and delivery of Alberta's resources take place in a manner that is fair, responsible and in the public interest.

Alberta Environment (AENV) Provincial ministry that looks after the following: establishes policies, legislation, plans, guidelines and standards for environmental management and protection; allocates resources through approvals, dispositions and licenses, and enforces those decisions; ensure water infrastructure and equipment are maintained and operated effectively; and prevents, reduces and mitigates floods, droughts, emergency spills and other pollution-related incidents.

Alberta Environment and Water (AEW) Provincial ministry that looks after the following: establishes policies, legislation, plans, guidelines and standards for environmental management and protection; allocates resources through approvals, dispositions and licenses, and enforces those decisions; ensure water infrastructure and equipment are maintained and operated effectively; and prevents, reduces and mitigates floods, droughts, emergency spills and other pollution-related incidents.

Alberta Sustainable Resource Development (ASRD)	Alberta Sustainable Resource Development (ASRD) is one of the Alberta Ministries whose mission is to encourage balanced and responsible use of Alberta's natural resources through the application of leading practices in management, science and stewardship. ASRD works with Albertans across the province to ensure a balance between the economic, environmental and social values of our province. They fight forest fires, manage fish and wildlife, oversee the development of Alberta's forests, and manage the use of public lands.
Alkalinity	A measure of water's capacity to neutralize an acid. It indicates the presence of carbonates, bicarbonates and hydroxides, and less significantly, borates, silicates, phosphates and organic substances. Alkalinity is expressed as an equivalent of calcium carbonate. Its composition is affected by pH, mineral composition, temperature and ionic strength. However, alkalinity is normally interpreted as a function of carbonates, bicarbonates and hydroxides. The sum of these three components is called total alkalinity.
Ambient	The conditions surrounding an organism or area.
Ambient Air	The air in the surrounding atmosphere.
Ambient Noise	All noises that exist in an area and are not related to a facility covered by Directive 038. Ambient noise includes sound from other industrial noise not subject to the directive, transportation sources, animals and nature.
Ambient Sound Level	Background sound level: the sound level that is present in the acoustic environment of a defined area. Ambient sound can include sources from transportation equipment, animals and nature.
Amphibians	Any of the class of cold-blooded vertebrates such as frogs, toads, and salamanders intermediate between fishes and reptiles; they have gilled aquatic larva and air-breathing adults.
Anion	An ion or group of ions having a negative charge.
Anthropogenic	Caused by human activity.
Application Case	The Environmental Impact Assessment (EIA) case including the project that is the subject of the application, existing environmental conditions, and existing and approved projects or activities.

Aquifer A body of rock or soil that contains sufficient amounts of saturated permeable material to yield economic quantities of water to wells or springs.

Any water-saturated body of geological material from which enough water can be drawn at a reasonable cost for the purpose required. An aquifer in an arid prairie area required to supply water to a single farm may be adequate if it can supply 1 m3/d. This would not be considered an aquifer by any industry looking for cooling water in volumes of 10,000 m^3/d. A common usage of the term aquifer is to indicate the water-bearing material in any area from which water is most easily extracted.

Aquitard A material of low permeability between aquifers. An aquitard allows some measure of leakage between the aquifers it separates.

Archaeology The scientific study of the unwritten portion of human historic and prehistoric past.

Area Source An area source is a two-dimensional source of diffuse air pollutant emissions (e.g., forest fire).

Artifact Any portable object modified or manufactured by humans.

Attenuation (Noise) A reduction in sound level that occurs with sound propagation over distance by means of physical dissipation or absorption mechanisms, or a reduction in sound level that occurs by means of noise control measures applied to a sound source.

A-weighted Sound Level The ear does not respond equally to all frequencies. But is less sensitive at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultants sound level is said to be A-weighted, and the units are dBA.

Base Case The EIA assessment case that includes existing environmental conditions as well as existing and approved projects or activities.

Base Cation An alkali or alkaline earth metal cation (Ca^{2+}, Mg^{2+}, K^+, Na^+).

Baseline A surveyed or predicted condition that serves as a reference point to which later surveys are coordinated or correlated.

Baseline Case The EIA assessment case that includes existing environmental conditions as well as existing and approved projects or activities.

Basin A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or artificial (constructed) lakes.

Bathymetry Measurement of the depth of an ocean or large waterbody.

Bedrock The body of rock that underlies gravel, soil or other subregion material.

Bedrock Aquifer A bedrock formation that has the ability to contain and transmit groundwater. Typical examples include sandstone and siltstone or other fractured rock types.

Benthic Invertebrates Invertebrate organisms living at, in or in association with the bottom (benthic) substrate of lakes, ponds and streams. Examples of benthic invertebrates include some aquatic insect species (such as caddisfly larvae) that spend at least part of their lifestages dwelling on bottom sediments in the waterbody.

These organisms play several important roles in the aquatic community. They are involved in the mineralization and recycling of organic matter produced in the water above, or brought in from external sources, and they are important second and third links in the trophic sequence of aquatic communities. Many benthic invertebrates are major food sources for fish.

Bioaccumulation When an organism stores within its body a higher concentration of a substance than is found in the environment. This is not necessarily harmful. For example, freshwater fish must bioaccumulate salt to survive in intertidal waters. Many toxicants, such as arsenic, are not included among the dangerous bioaccumulative substances because they can be handled and excreted by aquatic organisms.

Bioconcentration A process where there is a net accumulation of a chemical directly from an exposure medium into an organism.

Biodiversity The variety of plant and animal life in a particular habitat (e.g., plant community or a country). It includes all levels of organization, from genes to landscapes, and the ecological processes through which these levels are connected.

Biogenic Produced by living organisms.

Biota Living organisms and vegetation.

Biotic The living organisms in an ecosystem.

Bitumen A highly viscous, tarry, black hydrocarbon material having an API gravity of about 9 (specific gravity about 1.0). It is a complex mixture of organic compounds. Carbon accounts for 80 to 85% of the elemental composition of bitumen, hydrogen 10%, sulphur 5%, and nitrogen, oxygen and trace elements form the remainder.

Bog Sphagnum or forest peat materials formed in an ombrotrophic environment due to the slightly elevated nature of the bog, which tends to disassociate it from the nutrient-rich groundwater or surrounding mineral soils. Characterized by a level, raised or sloping peat surface with hollows and hummocks.

Mineral-poor, acidic and peat-forming wetlands that receives water only from precipitation.

Borden Number A site designation system used in Canada to identify the location of individual archaeological sites based on degrees and minutes of latitude and longitude, and the number of sites located within that map unit.

Boreal Forest The northern hemisphere, circumpolar, tundra forest type consisting primarily of black spruce and white spruce with balsam fir, birch and aspen.

Borrow Area A bank or pit from which earth is taken for use in filling or embanking. Often used in the construction of roads.

Brunisolic Soil An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of the other orders. These soils, which occur under a wide variety of climatic and vegetative conditions, all have Bm or Btj horizons.

Bryophyte Non-vascular plants from the phylum Bryophyta. Species within this phylum include mosses, liverworts and hornworts.

Buffering The capability of a system to accept acids without the pH changing appreciably. The greater amounts of the conjugate acid-base pair, the more resistant they are to a change in pH.

Buried Valley An eroded depression in the soil or bedrock within which sediments of high permeability (e.g., sand) or low permeability (e.g., till, clay) accumulate.

Calendar day Stream day multiplied by a service factor for planned and unplanned downtime.

CALMET	A meteorological model that includes a diagnostic wind field generator containing objective analysis and parameterized treatments of slope flow, kinematic terrain effects, terrain blocking effects with a divergence minimization procedure, and a micrometeorological model for overland and overwater boundary layers.
CALPUFF	A non-steady Lagrangian Gaussian Puff Model containing modules for complex terrain effects, overwater transport interaction effects, building downwash, wet and dry removal, and simple chemical transformation.
Canid	Any animal of the family Canidae, a family of mammals including dogs, jackals, wolves and foxes, typically having a bushy tail, erect ears and a long muzzle: order Carnivora (carnivores).
Canopy	An overhanging cover, shelter or shade. The tallest layer of vegetation in an area.
Cap Rock	A relatively impervious rock overlying an oil- or gas-bearing formation.
Carcinogen	An agent that is reactive or toxic enough to act directly to cause cancer.
Carnivore	Any of an order of mammals that feed chiefly on flesh or other animal matter rather than plants.
Carrying Capacity	The maximum population size that can be supported by the available resources.
Catchment Area	The area of land from which water finds its way into a particular watercourse, lake or reservoir (Also termed “river basin” or “watershed.”)
Cation	A positively charged ion.
Cation Exchange Capacity	The sum total of exchangeable cations that a soil can adsorb. It is usually expressed in milliequivalents per 100 grams of soil.
Channel	The bottom of a flowing body of water that may be eroded into the underlying bedrock. The bed of a stream or river.
Channel Regime	The morphological characteristics, including cross-section, longitudinal slope and sinuosity, of a watercourse that is in long-term equilibrium.
Chemical of Potential Concern	A chemical that is emitted or released into the environment and poses a potential risk of exposure to humans.

Chi-Square Analysis A statistical test to determine if the patterns exhibited by data could have been produced by chance.

Chlorophyll *a* One of the green pigments in plants. It is a photo-sensitive pigment that is essential for the conversion of inorganic carbon (e.g., carbon dioxide) and water into organic carbon (e.g., sugar). The concentration of chlorophyll a in water is an indicator of algal concentration.

Chlorosis A yellowing of leaf tissue due to a lack of chlorophyll. Possible causes of chlorosis include poor drainage, damaged roots, compacted roots, high alkalinity, and nutrient deficiencies in the plant.

Chronic The development of adverse effects after extended exposure to a given substance. In chronic toxicity tests, the measurement of a chronic effect can be reduced growth, reduced reproduction or other non-lethal effects, in addition to lethality. Chronic should be considered a relative term depending on the life span of the organism.

Closed Canopy Dense cover in the topmost vegetation layer in a community, usually limiting the light available to the forest floor.

Collapse Scar Areas where permafrost has melted, causing the ground above to slump below the surrounding area, often with “ripped” edges.

Colluvial Massive to moderately well sorted, non sorted and poorly sorted sediments with any range of particle sizes that have reached their present position by gravity induced movement.

Concentration Quantifiable amount of a chemical in environmental media.

Conductivity A measure of the capacity of water to conduct an electrical current. It is the reciprocal of resistance. This measurement provides an estimate of the total concentration of dissolved ions in the water.

Coniferous Bearing cones or strobili (a cone-like cluster).

Contaminants Any chemical compound added to a receiving environment in excess of natural concentrations. Contaminants include chemicals or effects not generally regarded as “toxic”, such as nutrients, colour and salts.

Country Foods Country foods are dietary items from the local region which are used for sustenance. Country food items include: fruit, vegetables, herbs, medicinal plants, fish and game.

Cretaceous	A period of the Mesozoic era thought to have covered the span of time between 140 and 65 million years ago; also, the corresponding system of rocks.
Critical Load	A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge. For waterbody acidification, the critical load represents an estimate of the amount of acidic deposition below which significant adverse changes are not expected to occur in a lake's ecosystem.
Cryosol	Cryosolic soils are mineral or organic soils that have perennially frozen material within 1 m of the surface in some part of the soil body, or pedon.
Cumulative Effects	The combined effects of past, present and reasonably foreseeable activities, over time, on people and the environment.
Cumulative Environmental Management Association (CEMA)	An association of oil sands industry, other industry, regional community representatives, regulatory agencies and other stakeholders designed to develop systems to manage cumulative effects associated with developments in the Region.
Cutblock	Previously forested area that has been harvested for timber and is presently regenerating at various stages of regrowth.
C-weighted Sound Level	A quantity, in decibels, read from a standard sound level meter that is switched to the weighting network labelled "C". The C-weighting network weights the frequencies between 70 and 400 Hz, uniformly, but below and above these limits, frequencies are slightly discriminated against.
dBA	A decibel value which has been A-weighted, or filtered to match the response of the human ear.
dBC	A decibel value which has been C-weighted, or filtered to highlight low frequency content.
Decibel (dB)	The standard unit of measure, in acoustics. A logarithmic ratio of the measured pressure fluctuation and reference pressure.
Deciduous	Tree species that lose their leaves at the end of the growing season.
Dermal Contact	A person can be exposed to chemicals in soil when soil particles adhere to the skin. That is, chemicals in soil may be absorbed through the skin and enter the bloodstream. This is typically a minor exposure pathway that is included in a multi-media risk assessment.

Devonian	A period of the Paleozoic era thought to have covered the span of time between 400 and 345 million years ago; also, the corresponding system of rocks.
Digital Elevation Model (DEM)	A three-dimensional grid representing the height of a landscape above a given datum.
Dilbit	Any blend of diluent and bitumen.
Diluent	A light liquid hydrocarbon added to bitumen to lower viscosity and density. The thinning agent is used by the oil sands to make heavy oil more fluid so it can be transported.
Dissolved Organic Carbon (DOC)	The dissolved portion of organic carbon water; made up of humic substances and partly degraded plant and animal materials.
Dissolved Oxygen (DO)	Measurement of the concentration of dissolved (gaseous) oxygen in the water, usually expressed in milligrams per litre (mg/L).
Disturbance Coefficient	The effectiveness of the habitat within the disturbance zone of influence in fulfilling the requirements of a species.
Diurnal	Relating to a 24-hour time period.
Dose	A measure of integral exposure. Examples include: (1) the amount of chemical ingested; (2) the amount of a chemical taken up; and (3) the product of ambient exposure concentration and the duration of exposure.
Drainage Basin	A region of land that eventually contributes water to a river or lake.
Drawdown	Lowering of water level caused by pumping. It is measured for a given quantity of water pumped during a specified period, or after the pumping level has become constant.
Ecodistrict	A broad subdivision of the landscape based on differences in landscape pattern, topography and dominant soils.
Ecological Land Classification (ELC)	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.

Ecosite Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.

Ecosite Phase A subdivision of the ecosite based on the dominant tree species in the canopy. On some sites where the tree canopy is lacking, the tallest structural vegetation layer determines the ecosite phase.

Ecosystem An integrated and stable association of living and non-living resources functioning within a defined physical location. A community of organisms and its environment functioning as an ecological unit. For the purposes of assessment, the ecosystem must be defined according to a particular unit and scale.

Edge Where different plant communities meet in space on a landscape; and where plant communities meet a disturbance. An outer band of a patch that usually has an environment significantly different from the interior of the patch.

Edge Effect An ecological effect associated with patch edges. An outer band of a plant community that usually has an environment significantly different from the interior of the plant community.

Ekman Grab Cube-shaped mechanical device with a spring-loaded opening that is lowered to the bottom of a waterbody and triggered to close as to collect a sample of the bottom substrate.

Electrical Conductivity The capability of a solution to transmit an electrical current. A capability closely related to the concentration of salts in soils.

Elution Process whereby a component of a solution (usually attached to a solid phase, such as ice crystals) is extracted by movement of a solvent.

Empress Channel Aquifer Coarse grained sediments (i.e., sand and gravel) of the Empress Formation. These sediments generally occur within discrete channel features but are referred to collectively as the Empress Channel Aquifer. Where the Empress Channel Aquifer occurs within a particular channel, such as the Birch Channel, it is referred to as the Empress Birch Channel Aquifer.

Energy and Utilities Board (EUB)
An independent, quasi-judicial agency of the Government of Alberta, the EUB was created in February 1995 by the amalgamation of the Energy Resources Conservation Board and the Public Utilities Board. The purpose of the EUB was to ensure that the discovery, development, and delivery of Alberta's resources take place in a manner that is fair, responsible and in the public interest. This Board has since been realigned into two separate regulatory bodies (January 1, 2008), the Energy Resources Conservation Board (ERCB), which regulates the energy industry, and the Alberta Utilities Commission (AUC), which regulates the utilities industry.

Energy Resources Conservation Board (ERCB)
The Energy Resources Conservation Board (ERCB) is an independent, quasi-judicial agency of the Government of Alberta. The ERCB was created on January 1, 2008 as a result of the realignment of the Alberta Energy and Utilities Board (EUB) into the ERCB and the Alberta Utilities Commission (AUC). The ERCB also includes the Alberta Geological Survey. The purpose of the ERCB is to ensure that the discovery, development and delivery of Alberta's resources take place in a manner that is fair, responsible and in the public interest. The ERCB regulates the safe, responsible, and efficient development of Alberta's energy resources: oil, natural gas, oil sands, coal and pipelines.

Environmental Impact Assessment (EIA)
A review of the effects that a proposed development will have on the local and regional environment.

Eolian
Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that are well sorted, poorly compacted, that are laid down by atmospheric current, and that may show internal structures such as cross-bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

Ephemeral
A phenomenon or feature that lasts only a short time (e.g., an ephemeral stream is only present for short periods during the year).

Epiphyte
A plant that grows upon another plant, but is neither parasitic on it nor rooted in the ground.

Episodic Acidification
Also known as a spring acid pulse. It is the sudden delivery of acidic substances to an aquatic receptor as a result of high flow rates in the catchment. The flow rates increase as a result of rapid snowmelt in the spring and large rain events; only the former is considered in this report.

Ericaceous	Plant species belonging to the heath family (Ericaceae) and typically prefer acid soil.
Erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
Eskers	Long, narrow bodies of sand and gravel deposited by a subglacial stream running between ice walls or in an ice tunnel, left behind after melting of the ice of a retreating glacier.
Estuarine	Formed or deposited in an estuary; *estuarine muds*: or growing in, inhabiting, or found in an estuary; *an estuarine fauna*.
Eutrophic	The nutrient-rich status (amount of nitrogen, phosphorus and potassium) of an ecosystem.
Eutrophication	The over fertilization of a body of water, which generally results in increased plant growth and decay. This ultimately leads to an increase in simple algae and plankton over more complex plant species, resulting in a decrease in water quality. Causes of eutrophication can be anthropogenic or natural.
Evaporation	The process by which water is changed from a liquid to a vapour.
Evaporite	A sediment that is deposited from aqueous solution as a result of extensive or total evaporation.
Evapotranspiration	A measure of the capability of the atmosphere to remove water from a location through the processes of evaporation and water loss from plants (transpiration).
Exposure	The contact reaction between a chemical and a biological system, or organism. Estimated dose of chemical that is received by a particular receptor via a specific exposure pathway (e.g., ingestion, inhalation); expressed as the amount of chemical received, per body weight, per unit time (i.e., mg/kg/day).
Exposure Pathway or Route	The route by which a receptor comes into contact with a chemical or physical agent. Examples of exposure pathways include: the ingestion of water, food and soil; the inhalation of air and dust; and dermal absorption.
Exposure Ratio (ER) or Hazard Quotient (HQ)	A comparison between total exposure from all predicted routes of exposure and the exposure limits for chemicals of concern. This comparison is calculated by dividing the predicted exposure by the exposure limit. Also referred to as hazard quotient (HQ).

Extirpated A species no longer existing in the wild in Canada, but exists elsewhere in the world.

Facies change A lateral or vertical variation in the lithologic characteristics of contemporaneous sedimentary deposits. It is caused by, or reflects, a change in depositional environment.

Far Future Defined as 80 years following final reclamation.

Fate In the context of the study of contaminants, fate refers to the chemical form of a contaminant when it enters the environment and the compartment of the ecosystem in which that chemical is primarily concentrated (e.g., water or sediments). Fate also includes transport of the chemical within the ecosystem (via water, air or mobile biota) and the potential for food chain accumulation.

Fate Transport Parameters The mechanism by which pollutants move through and are ultimately deposited within media such as air, water or soil.

Fecundity The most common measure of reproductive potential in fishes. It is the number of eggs in the ovary of a female fish. It is most commonly measured in gravid (pregnant) fish. Fecundity increases with the size of the female.

Felids Members of the cat family.

Fen Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in a eutrophic environment due to the close association of the material with mineral rich waters. Minerotropic peat-forming wetlands that receive surface moisture from precipitation and groundwater. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium.

First Nation A term that came into common usage in the 1970s to replace the term Indian band, Although the term First Nation is widely used, no legal definition of it exists. The term has generally come to refer to Aboriginal groups that have status under the *Indian Act*. Some Aboriginal groups have also adopted the term First Nation to replace the word band in the name of their community.

Fish Fish as defined in the Fisheries Act, includes parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fish Habitat Fish habitat, as defined in the *Fisheries Act*, includes the spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes.

Flutings a type of glacial landform

Fluvial Relating to a stream or river.

Footprint The proposed development area that directly affects the terrestrial vegetation, wetlands and forestry components of the landscape. The area of soil disturbance may be less.

Forage Fish Small fish that provide food for larger fish (e.g., longnose sucker, fathead minnow).

Forb A broad-leaved herb that is not a grass.

Fragmentation The process of breaking into pieces or sections. For example, dividing contiguous tracts of land into smaller and less connected sections through site clearing (e.g., for roads).

FRAGSTATS A spatial pattern analysis software program used to quantify the areal extent and spatial configuration of patches within a landscape. The analysis is done using categorical spatial data (e.g., plant communities).

Freeboard The distance between the water level and the top of a containing structure such as a dyke crest or channel top of bank.

Frequency (Hz) The number of oscillations or cycles per unit time. Acoustical frequency is expressed in units of Hertz (Hz) where one Hz is one cycle per second.

Fugitive Emissions Substances emitted from any source except those from stacks and vents. Typical sources include gaseous leakage from valves, flanges, drains, volatilization from ponds and lagoons, and open doors and windows. Typical particulate sources include bulk storage areas, open conveyors, construction areas or plant roads.

Fumigation Exposure to potentially toxic substances such as sulphur dioxide (SO_2) or nitrogen dioxide (NO_2) in gaseous form.

Furbearer Mammals that have traditionally been trapped or hunted for their fur, including badger, beaver, cougar, coyote, fisher, lynx, marten, mink, muskrat, otter, porcupine, rabbit, red fox, skunk, squirrel, weasel, wolf and wolverine.

Geographic Information System (GIS)	Computer software designed to develop, manage, analyze and display spatially referenced data.
Geomorphic	The natural evolution of surface soils and landscape over long periods.
Geomorphology	The science of surface landforms and their interpretation on the basis of geology and climate. That branch of science that deals with the form of the earth, the general configurations of its surface and the changes that take place in the evolution of landforms.
Gibbsite	A solid phase of aluminum hydroxide $Al(OH)_3$. It is the predominant aluminum-containing mineral in the Oil Sands Region and hence used to approximate equilibrium aluminum concentrations in the environment.
Glacial Flutes	Glacial flutes refers to parallel ridges or grooves within a morainal landscape. These features formed parallel to ice flow direction, can be found singly or in groups, generally in the transition and active zone of ice sheet advance.
Glacial Till	Unsorted and unstratified glacial drift (generally unconsolidated) deposited directly by a glacier without subsequent reworking by water from the glacier. Consisting of a heterogeneous mixture of clay, silt, sand, gravel and boulders (i.e., drift) varying widely in size and shape.
Glaciofluvial (or Glacio-Fluvial)	Sediments or landforms produced by melt waters originating from glaciers or ice sheets. Glaciofluvial deposits commonly contain rounded cobbles arranged in bedded layers.
Glaciolacustrine (or Glacio-Lacustrine)	Sediments that were deposited in lakes that formed at the edge of glaciers when the glaciers receded. Glaciolacustrine sediments are commonly laminar deposits of fine sand, silt and clay.
Gleysolic Soil	An order of soils that have properties indicating prolonged, intermittent or continuous saturation with water during soil development. Diagnostic horizon is either Bg or Cg.
Global Positioning System (GPS)	A system of satellites, computers and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.
Graminoid	Grasses and grass-like plants such as sedges and rushes.

Ground Heave The deformation of the ground surface, in this case referring to increased elevation, resulting from a subsurface upward force. The forces involved may include hydrostatic pressure including freezing of the ground, injection of high pressure steam, or by thermal expansion of the subsurface due to the heating of the oil sands ore body during operation of steam injection production wells.

Groundtruth or Groundtruthing Visiting locations in the field to confirm or correct information produced from remote sources such as interpreted aerial photographs or classified satellite imagery.

Groundwater That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.

Groundwater That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.

Groundwater Discharge The volumetric flow of groundwater from an aquifer to ground surface (springs or seeps) or a surface waterbody.

Guild A set of co-existing species that share a common resource.

Habitat The place or environment where a plant or animal naturally or normally lives or occurs.

Habitat Fragmentation Occurs when extensive, continuous tracts of habitat are reduced by habitat loss to dispersed and usually smaller patches of habitat. Generally reduces the total amount of available habitat and reduces remaining habitat into smaller, more isolated patches.

Habitat Patches Isolated patches of habitat.

Habitat Suitability Index (HSI) Model Analytical tools for determining the relative potential of an area to support individuals or populations of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife as a result of various land use activities.

Habitat Unit Generally, used in Habitat Suitability Index models. A habitat is ranked in regards to its suitability for a particular wildlife species. This ranking is then multiplied by the area (hectares) of the particular habitat type to give the number of habitat units (HU) available to the wildlife species in question.

Hardness	Calculated mainly from the calcium and magnesium concentrations in water; originally developed as a measure of the capacity of water to precipitate soap. The hardness of water is environmentally important since it is inversely related to the toxicity of some metals (e.g., copper, nickel, lead, cadmium, chromium, silver and zinc).
Headwater	The source and upper reaches of a stream; also the upper reaches of a reservoir. The water upstream from a structure or point on a stream. The small streams that come together to form a river. Also may be thought of as any and all parts of a river basin except the mainstem river and main tributaries.
Heel	The location on the horizontally portion of a directionally drilled well that is nearest to the vertical portion of the drilled well.
Herb	Tender vascular plant, lacking woody stems, usually small or low; it may be annual or perennial, broadleaf (forb) or graminoid (grass).
Herbivore	Herbivores are animals that eat plants.
Heterogeneity	Consisting of parts that are unlike each other. For example, the variety and abundance of ecological units (e.g., ecosite phases and wetlands types) comprising a landscape mosaic.
Hibernacula	A protective care, covering, or structure, such as a plant bed, in which an organism remains dormant for the winter.
Highlands	Regions found on the sides and tops of plateaus and hilly moraines.
Hinterland	Sparsely population region outside of the Regional Municipality of Wood Buffalo urban and rural service areas and does not include project accommodations and campgrounds.
Historic/Heritage Resources	Works of nature or of humans, valued for their palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest.
Historic Resources Impact Assessment (HRIA)	A review of the effects that a proposed development will have on the local and regional historic and prehistoric heritage of an area.
Home Range	The area within which an animal normally lives, and traverses as part of its annual travel patterns.
Horizontal Fens	A flat peat surface not broken by marked elevations and depressions.

Humic Material Material from the humus portion of the soil, which is the dark, relatively stable organic part, which is so well decomposed that the original sources cannot be identified.

Hummocky A very complex sequence of slopes extending from somewhat rounded depression or kettles or various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls and depressions.

Humus Organic matter which has reached a point of stability and will not degrade further. Humus has a characteristic dark brown/black color due to an accumulation of black carbon.

Hydraulic Conductivity A parameter "K", that depends on the physical properties of formation and fluid. It describes the "ease" with which a fluid will flow through a porous material. "K" is the rate of flow per unit cross- sectional area under the influence of a unit gradient, and has the dimension of:

$Length^3/Length^2 \times Time$ or Length/Time (e.g., m/s), but should not be confused with velocity.

Hydraulic Head The elevation, with respect to a specified reference level, at which water stands in a piezometer (a pipe in the ground used to measure water elevations/or a small diameter observation well) connected to the point in question in the soil. Its definition can be extended to soil above the water table if the piezometer is replaced by a tensiometer (instrument used to measure moisture content of soil). The hydraulic head in systems under atmospheric pressure may be identified with a potential expressed in terms of the height of a water column. More specifically, it can be identified with the sum of gravitational and capillary potentials, and may be termed the hydraulic potential.

Hydric Soil moisture conditions where water is removed so slowly that the water table is at or near the soil surface all year; has organic and gleyed mineral soils.

Hydrogen Sulphide Hydrogen sulphide is a colourless gas with strong odour of rotten eggs. It comes from industrial fugitive emissions by way of petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants using the Kraft pulping process and animal feedlots. Natural sources include sulphur hot springs, sloughs, swamps and lakes.

Hydrogeology The study of the factors that deal with subsurface water (groundwater) and the related geologic aspects of surface water. Groundwater as used here includes all water in the zone of saturation beneath the earth's surface, except water chemically combined in minerals.

Hydrological Simulation Program – Fortran (HSPF) A comprehensive, conceptual, continuous watershed simulation model designed to simulate the water quantity and water quality processes that occur in a watershed. The model can reproduce spatial variability by dividing the basin in hydrologically homogeneous land segments and simulating runoff for each land segment independently, using segment-specific meteorological input data and watershed parameters.

Hydrology The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.

Hydrostratigraphic Unit A formation, part of a formation, or group of formations in which there are similar hydrologic characteristics allowing for grouping into aquifers or confining layers.

Hyper-Eutrophic Trophic state classification for lakes characterized by high primary productivity and high nutrient inputs (particularly total phosphorus). Hyper-eutrophic lakes are characterized by abundant plant growth, algal blooms and oxygen depletion.

Illuvial A soil layer or horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. This layer of accumulation contains illuvial deposits of clays, oxides, and organics accumulated in a soil horizon classified as “B horizons”.

Incremental Lifetime Cancer Risk (ILCR) The risk associated with daily exposure to a carcinogenic chemical that is separate from the risk associated with assumed background exposures.

In Situ Also known as “in place”. Refers to methods of extracting deep deposits of oil sands without removing the groundcover. The in-situ technology in oil sands uses underground wells to recover the resources with less impact to the land, air and water than for oil sands mining.

Internal Lawn Wet depressional area within bog or fen wetlands types that are absent of trees and contain species adapted to wetter conditions than the surrounding wooded habitat. In bogs, internal lawns contain wet *Sphagnum* species and sedges and represent previous areas of permafrost that have degraded in the past. In fens, internal lawns contain wetter species of *Sphagnum* or brown moss.

Invasive Species A species that has moved into an ecosystem and reproduced so successfully that it has displaced the original structure of the community.

Inversion Layer An atmospheric layer wherein the temperature increases with increasing altitude.

Invertebrates Any animal lacking a backbone, including all species not classified as vertebrates.

Isopach Map A geological map of subsurface strata showing the various thicknesses of a given formation underlying an area.

Isopleth A line on a map connecting places sharing the same feature (e.g., ground-level concentrations).

Isopleth A line on a map connecting places sharing the same feature (e.g., ground-level concentrations).

Kame Ice contact deposits associated with the concurrent processes of melting ice and flowing meltwater.

Key Indicator Resources (KIRs) Environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic or aesthetic value.

Keystone Species A species that is of particular importance to community integrity and function, without which significant changes to the community would occur.

Lacustrine Sediment that have been transported or deposited by water or wave action. Generally consisting of stratified sand, silt or clay deposited on a lake bed or moderately well sorted and stratified sand and coarser material.

Land Capability Class A land capability class assigned to an area according to the criteria outlined in Land Capability Classification System for Forest Ecosystems in the Oil Sands, 3rd Edition, as amended.

Land cover type Ecosite phases, wetlands types, disturbance and other land cover types; used to describe land cover in the LSA.

LANDSAT 5 A specific satellite or series of satellites used for earth resource remote sensing. Satellite data can be converted to visual images for resource analysis and planning.

Landscape A heterogeneous land area with interacting ecosystems that are repeated in similar form throughout. From a wildlife perspective, a landscape is an area of land containing a mosaic of habitat patches within which a particular "focal" or "target" habitat patch is embedded.

Landscape Connectivity A measure of the probability that individuals are capable of moving across a landscape and colonizing suitable habitat patches within their dispersal range.

Laydown Area An area that has been cleared for the temporary storage of equipment and supplies. Laydown areas are usually covered with rock and/or gravel to ensure accessibility and safe maneuverability for transport and off-loading of vehicles.

Leaf Area Index (LAI) The ratio of leaf area to soil surface area.

Lichen Any complex organism of the group Lichenes, composed of a fungus in symbiotic union with an alga and having a greenish, grey, yellow, brown, or blackish thallus that grows in leaflike, crustlike, or branching forms on rocks, trees and other surfaces.

Linear Disturbance Cutlines, pipelines, rights-of-ways, and transmission lines (but not roads).

Lithic Consolidated bedrock (r) within the control section below a depth of 10 cm. The upper surface of a lithic layer is a lithic contact.

Lithic Scatters A small concentration of lithic (stone) artifacts on the surface. This term is usually used when there is insufficient information present to identify the function of the site.

Lithology The gross physical character of a rock/soil formation.

Litter, Fibric and Humic (LFH) Organic layers developed primarily from leaves, twigs and wood materials with minor components of mosses. The forest floor that accumulates on the mineral soil surface under forest vegetation, and which includes dead vegetation and organic matter, including litter and unincorporated humus.

Littoral Zone	The zone in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about 1% of the surface light) for rooted aquatic plants and algae to colonize the bottom sediments.
Lmax	Maximum noise level measured during a specified time interval. Typically this mean the maximum .1second noise level registered during a 1 minute period.
Local Study Area - Maximum Point of Impingement (LSA MPOI)	The LSA MPOI (maximum point of impingement) is the highest ground-level concentration as predicted by the air quality model within this area.
Local Study Area (LSA)	Defines the spatial extent directly or indirectly affected by the Project.
Long Run Sustained Yield Average	The sum of Mean Annual Increments (MAI) for all forest cover types in a study area. The LRSYA is an estimate for the sustained yield or expected annual growth of the coniferous and deciduous fibre in a study area.
Long Run Sustained Yield Average (LRSYA)	The sum of Mean Annual Increments (MAI) for all forest cover types in a study area. The LRSYA is an estimate for the sustained yield or expected annual growth of the coniferous and deciduous fibre in a study area.
Lotic	Of or relating to or living in actively moving water.
Low Frequency Noise (LFN)	Where a clear tone is present below and inclusive of 250 Hz. Low frequency noise can be estimated by subtracting the overall C-weighted from the overall A-weighted sound level, or as the overall C-weighted sound level by itself.
Lowest Observed Adverse Effect Level (LOAEL)	In toxicity testing, it is the lowest concentration at which adverse effects on the measurement end point are observed.
Lowland Areas	Areas with ground slopes of less than 0.5% and typically poorly drained.
Luvisol	An order of soils that have eluvial (Ae) horizons and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils developed under forest or forest-grassland transition in a moderate to cool climate.
Macrophytes	Plants large enough to be seen by the unaided eye. Aquatic macrophytes are plants that live in or in close proximity to water.

Mainstem	The main portion of a watercourse extending continuously upstream from its mouth, but not including any tributary watercourses.
Make-up Water	The process water required to replace that lost by evaporation or leakage in a closed-circuit, recycle operation.
Marsh	A non-peat-forming, nutrient-rich wetlands characterized by frequent flooding and fluctuating water levels.
McMurray Basal Aquifer	The interval of McMurray Formation that is lean of, or contains no bitumen, and is located at the base of McMurray.
Mean	Arithmetic average; the sum of values divided by the total number of values.
Mean Annual Increment	The measure of cubic metres of fibre that accumulates per year from each hectare of forest. Calculated MAI for each stand is summed by forest cover type, and multiplied by its area to derive expected fibre accumulation for that forest cover type.
Mean Annual Increment (MAI)	The measure of cubic metres of fibre that accumulates per year from each hectare of forest. Calculated MAI for each stand is summed by forest cover type, and multiplied by its area to derive expected fibre accumulation for that forest cover type.
Merchantable Forest	A forest area with potential to be harvested for production of lumber/timber or wood pulp. Forests with a timber productivity rating of moderate to good.
Mesic	A moderate soil moisture regime value whereby water is removed somewhat slowly in relation to supply; neither wet nor dry. Available soil water reflects climatic inputs.
Mesoscale	Pertaining to atmospheric phenomena having horizontal scales ranging from a few to several hundred kilometres.
Mesotrophic	Trophic state classification for lakes characterized by moderate productivity and nutrient inputs (particularly total phosphorus).
Meteoric Water	Groundwater that has recently originated from the atmosphere.

Métis People of mixed Aboriginal and European ancestry who identify themselves as Métis, as distinct from First Nations people, Inuit or non-Aboriginal people. The Métis have a unique culture that draws on their diverse Aboriginal and European ancestral origins, such as Scottish, French, Ojibway and Cree.

Mineral Soil Soils containing low levels of organic matter. Soils that have evolved on fluvial, glaciofluvial, lacustrine and morainal parent material. The A, B, and C horizons and underlying parent material.

Mineralization of Groundwater Synonymous with total dissolved solids (typically reported in mg/L).

Mixedwood A terrestrial forest type that is an assemblage of both deciduous and coniferous tree species.

Mixing Height The distance between the Earth's surface and the bottom of inversion layer in the atmosphere.

Moisture Regime The relative moisture supply at a site available for plant growth.

Monitoring well A constructed controlled point of access to an aquifer which allows groundwater observations. Small diameter observation wells are often called piezometers.

Moraine Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Multi-Media Risk Assessment Multiple exposure pathways, including air inhalation, water ingestion, food ingestion, incidental soil ingestion, dermal contact and dust inhalation, are evaluated in a multi-media risk assessment. Exposures to chemicals of concern for each pathway are summed to determine total exposure for each chemical.

Muskeg A soil type comprised primarily of organic matter. Also known as bog peat.

Necrosis Death of cells or plant parts, usually resulting in the tissue turning brown or black due to oxidation of phenolics.

Nitrogen Dioxide	One of the component gases of oxides of nitrogen which also includes nitric oxide. In burning natural gas, coal, oil and gasoline, atmospheric nitrogen may combine with molecular oxygen to form nitric oxide, an ingredient in the brown haze observed near large cities. Nitric oxide is converted to nitrogen dioxide in the atmosphere. Cars, trucks, trains and planes are the major source of oxides of nitrogen in Alberta. Other major sources include oil and gas industries and power plants.
Nitrogen Oxides (NOx)	A measure of the oxides of nitrogen comprised of nitric oxide (NO) and nitrogen dioxide (NO_2).
No Observed Adverse Effect Level (NOAEL)	In toxicity testing, it is the highest concentration at which no adverse effects on the measurement end point are observed.
No Observed Effect Level (NOEL)	In toxicity testing, it is the highest concentration at which no effects on the measurement end point are observed.
Node	Location along a river channel, lake inlet or lake outlet where flows, sediment yield and water quality have been quantified.
Non-Carcinogen	A chemical that does not cause cancer and has a threshold concentration, below which adverse effects are unlikely.
Non-Consumptive Recreation	See Recreation.
Non-saline Water	In Alberta, groundwater that has a measured Total Dissolved Solids (TDS) concentration of less than 4,000 mg/L is classified as non-saline water.
Non-Vascular Plant	Plants that do not possess conductive tissues (e.g., veins) for the transport of water and food.
Nutrient Regime	The relative supply of nutrients available for plant growth at a given site.
Nutrients	Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
Off-Reserve	A term used to describe people, services or objects that are not part of a reserve, but relate to First Nations.
Oil	An immiscible liquid comprised of a mixture of petroleum hydrocarbon compounds.

Oil Sands A sand deposit containing a heavy hydrocarbon (bitumen) in the intergranular pore space of sands and fine grained particles. Typical oil sands comprise approximately 10 wt% bitumen, 85% coarse sand (>44 μm) and a fines (<44 μm) fraction, consisting of silts and clays.

Oil Sands Region The Oil Sands Region includes the Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP.

Old Growth Forest An ecosystem distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species, composition, and ecosystem function. Old growth forests are those forested areas where the annual growth equals annual losses, or where the mean annual increment of timber volume equals zero. They can be defined as those stands that are self-regenerating (i.e., having a specific structure that is maintained).

Oligotrophic Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).

Organic Soil A soil order that have developed primarily on organic deposits. Soils containing high percentages of organic matter (fibric and humic inclusions).

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Overburden Unconsolidated material including sand, silt or clay that overlies consolidated bedrock.

Overstorey Those trees that form the upper canopy in a multi-layered forest.

Overwintering Habitat used during the winter as a refuge and for feeding.

Overwintering Habitat Habitat used during the winter as a refuge and for feeding.

Oxidation Reduction The electric potential to transfer electrons from one compound or element (the oxidant) to another compound or element (the reductant); used as a qualitative measure of the state of oxidation in water treatment systems.

Oxides of Nitrogen Oxides of nitrogen include gaseous compounds such as nitrogen oxide (NO) and nitrogen dioxide (NO_2), but may also include additional nitrogen species (e.g., N_2O, N_3O, etc.). NO_x are the primary precursor for trophospheric ozone.

Ozone (O_3) Ozone is a gas that occurs both in the Earth's upper atmosphere and at ground level. Ozone in the upper atmosphere protects living organisms by preventing damaging ultraviolet light from reaching the Earth's surface. Ground-level ozone is an air pollutant with harmful effects on the respiratory systems of animals.

Palaeontology The study of the forms of life existing in prehistoric or geologic times, as represented by the fossils of plants, animals and other organisms.

Palsa Bogs A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Parent Material Material (generally bedrock) from which soils typically obtain structure and minerals. Consolidated (rock) or unconsolidated (e.g., river deposits) material that has undergone some degree of physical or chemical weathering.

Participation Rate Refers to the labour force in the week (Sunday to Saturday) prior to Census Day, expressed as a percentage of the population 15 years and over excluding institutional residents.

Particulate Matter A mixture if small particles and liquid droplets, often including a number of chemicals, dust and soil particles.

Patch An area that is different from the area around it (e.g., vegetation types, non-forested areas). This term is used to recognize that most ecosystems are not homogeneous, but rather exist as a group of patches or ecological islands that are recognizably different from the parts of the ecosystem that surround them but nevertheless interact with them.

Patch Richness (PR) A measure of the number of different patch types that occur within a study area or landscape unit within a study area. The patch types used here are vegetation units.

Patterned Fen Peatlands that display a distinctive pattern due to alterations between open wet areas (flarks) and drier shrubby to wooded areas (strings).

Peat A material composed almost entirely of organic matter from the partial decomposition of plants growing in wet conditions.

Peatland Areas where there is an accumulation of peat material at least 40 cm thick. These are represented by bog and fen wetlands types.

Pelagic Inhabiting open water, typically well off the bottom. Sometimes used synonymously with limnetic to describe the open water zone (e.g., large lake environments).

Permafrost Permanently frozen ground (subsoil). Permafrost areas are divided into more northern areas in which permafrost is continuous, and those more southern areas in which patches of permafrost alternate with unfrozen ground.

Permeability The capacity of porous rock, sediment, soil or a medium for transmitting a fluid. Has dimensions $Length^2$. When measured in cm^2, the value of permeability is very small, therefore more practical units are commonly used (i.e., Darcy [D] or millidarcy [mD].

Permissible Sound Level (PSL) The allowable overall A-weighted sound level of noise from energy industry sources, as specified by the EUB Noise Control Directive, which may contribute to the sound environment of a residential location.

pH The degree of acidity (or alkalinity) of soil or solution. The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). A difference of one pH unit represents a ten-fold change in hydrogen ion concentration.

Piezometer A pipe in the ground in which the elevation of water levels can be measured, or a small diameter observation well.

Piscivorous Diet Feeding on fish.

Planned Development Case (PDC) The Planned Development Case includes the Application Case components and planned developments that have been publicly disclosed at least six months prior to submission of the Environmental Impact Assessment.

$PM_{2.5}$ Airborne particulate matter with a mean diameter less than 2.5 µm (microns) in diameter. This represents the fraction of airborne particles that can be inhaled deeply into the pulmonary tissue.

PNdBA The Perceived Noise Level for aircraft corrected for tonal qualities.

Point Count A circular plot survey where observers spend a prescribed time looking and listening for birds or toads.

Point Source	The U.S. Environmental Protection Agency (EPA) defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged (e.g., a Stack).
Polycyclic Aromatic Hydrocarbon (PAH)	A chemical by-product. Aromatics are considered to be highly toxic components of petroleum products. PAHs, many of which are potential carcinogens, are composed of at least two fused benzene rings. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.
Polygon	The spatial area delineated on a map to define one feature unit (e.g., one type of ecosite phase).
Population	A collection of individuals of the same species that potentially interbreed.
Population Viability Analysis (PVA)	A modelling process that uses estimates of landscape changes, demographic rates and environmental variation to calculate the probability of species extinction within a given period of time and space.
Porewater	Water between the grains of a soil or rock.
Porosity	The percentage of the bulk volume of a rock or soil that is occupied by interstices (minute openings or crevices), whether isolated or connected.
Potential Acid Input (PAI)	A composite measure of acidification determined from the relative quantities of deposition from background and industrial emissions of sulphur, nitrogen and base cations. Soil net PAI accounts for nitrogen retention and is the sum of sulphur and one-quarter of nitrogen flux minus base cation deposition.
Process Water	Process water includes boiler feed water, cooling water for heat exchangers or engine, chemicals dilution, etc.
Produced Water	A term used in the oil industry to describe water that is produced along with the oil and gas. Oil and gas reservoirs have a natural water layer (formation water) that lies under the hydrocarbons.
Propagules	Root fragments, seeds, and other plant materials that can develop into a plant under the right conditions.
Proposed Project Area	The Proposed Project Area consists of a 26, 527 ha area of land for which Canadian Natural owns exploration and development rights.
Rare Plant Community	Plant communities that are described as unusual, uncommon, of limited extent or encountered infrequently.

Rare Plants A native plant species found in restricted areas, at the edge of its range or in low numbers within a province, state, territory or country.

Raster A graphic structure where the data is divided into cells on a grid. An example would be a computer screen where an image is represented by horizontal lines of coloured pixels. Shapes are represented by cells of the same colour or content adjacent to each other

Reach A comparatively short length of river, stream channel or shore. The length of the reach is defined by the purpose of the study.

Receptor The person or organism subjected to exposure to chemicals or physical agents.

Receptor (Noise) A location where measurements or predictions of noise levels are made.

Recharge The infiltration of water into the soil zone, unsaturated zone and ultimately the saturated zone. This term is commonly combined with other terms to indicate some specific mode of recharge such as recharge well, recharge area, or artificial recharge.

Reclamation The restoration of disturbed land or wasteland to a state of useful capability. Reclamation is the initiation of the process that leads to a sustainable landscape (see definition), including the construction of stable landforms, drainage systems, wetlands, soil reconstruction, addition of nutrients and revegataion. This provides the basis for natural succession to mature ecosystems suitable for a variety of end uses.

Reclamation Suitability A relative quality ranking of soil materials for use in reclamation planning and implementation in Alberta. The suitability is determined through the evaluation of a suite of generic soil physical and chemical characteristics as identified in the Soil Quality Criteria Relative to Disturbance and Reclamation (Alberta Agriculture 1987).

Recreation Recreation consists of activities in which people are engaged for the purpose of enjoyment. Outdoor recreation can be either consumptive or non-consumptive. Consumptive recreation involves using or consuming a resource, e.g., hunting, fishing (non-catch and release), and berry picking. Non-consumptive recreation does not involve the consumption of a resource, e.g., walking, running, bike riding, horseback riding, skiing, ATV riding and snowmobiling. Where hunting and fishing are considered activities that are part of the subsistence or commercial economy (i.e., not purely recreational), this distinction is made in the text of the Application.

Reference Concentration (RfC)	For a specific chemical that is conceptually equivalent to an air quality objective, and is expressed in µS/m^3. It is an exposure limit that is established for chemicals which are locally acting (e.g., irritant chemicals), whose toxicity is dependent solely on the air concentration and not on the total internal dose received by multiple exposure pathways.
Reference Dose	Refers to the safe level or dose of a chemical for which exposure occurs through multiple pathways (i.e., inhalation, ingestion and dermal). It is most commonly expressed in terms of the total intake of the chemical per unit of body weight (e.g., mg/kg BW/day). This term applies only to threshold chemicals.
Region	The Region includes the Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP.
Regional Aquatics Monitoring Program (RAMP)	RAMP was established to determine, evaluate and communicate the state of the aquatic environment in the Athabasca Oil Sands Region.
Regional Land Cover Class	Terrestrial classes, wetlands classes, disturbance and other land cover classes; used to describe land cover in the RSA.
Regional Study Area (RSA)	Defines the spatial extent related to the cumulative effects resulting from the Project and other regional developments.
Regional Sustainable Development Strategy (RSDS)	A regulatory framework for balancing development of Alberta's oil sands resources with protection of the environment.
Relative Abundance	The proportional representation of a species in a sample or a community.
Relative Humidity	The ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation.
Reserve	Tract of land, the legal title to which is held by the Crown, set apart for the use and benefit of an Indian band.
Ribbed Fen	A pattern of parallel or reticulate low ridges associated with fens.
Riffle-Run-Pool	A mixture of flows and depth and providing a variety of habitats. Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little or no turbulence.

Riparian Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain or standing waterbody.

Riparian Area/zone The vegetated areas adjacent to a watercourse or waterbody that directly contributes to fish habitat by providing shade, cover and food production areas. Riparian areas are also important to vegetation and wildlife, and because they stabilize stream banks and shorelines. To minimize disturbance to fish habitat and prevent bank erosion, it is important to retain as much riparian vegetation as possible, especially the vegetation directly adjacent to the watercourse or waterbody.

Riparian Community Vegetation assemblages adjacent to streams and waterbodies and whose structure and function are influenced by, or dependent upon this aquatic association.

Riprap The placement of rocks along the edge of a watercourse or waterbody for shoreline stabilization or to support culverts, piers or other structures.

Risk The likelihood or probability that the toxic effects associated with a chemical or physical agent will be produced in populations of individuals under their actual conditions of exposure. Risk is usually expressed as the probability of occurrence of an adverse effect, i.e., the expected ratio between the number of individuals that would experience an adverse effect at a given time and the total number of individuals exposed to the factor. Risk is expressed as a fraction without units and takes values from 0 (absolute certainty that there is no risk, which can never be shown) to 1.0, where there is absolute certainty that a risk will occur.

Risk Assessment Process that evaluates the probability of adverse effects that may occur, or are occurring on target organism(s) as a result of exposure to one or more stressors.

Risk Characterization The process of evaluating the potential risk to a receptor based on comparison of the estimated exposure to the toxicity reference value.

Rough Broken An area having steep slopes and many intermittent drainage channels, but usually covered with vegetation.

Runoff The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate.

Rut A general term that refers to the breeding period of mammals, especially the ungulates. During the rut, males exhibit specific behaviours to establish harems or to attract females to mate with. A general term that refers to the breeding period of mammals, especially the ungulates. During the rut, males exhibit specific behaviours to establish harems or to attract females to mate with.

Saline Water In Alberta, groundwater that has a measured TDS concentration of more than 4,000 mg/L is classified as saline water.

Scavenging Removal of a pollutant from the air through chemical or physical processes such as dry deposition or washout by precipitation.

Sedge Any plant of the genus Carex, perennial herbs, often growing in dense tufts in marshy places. They have triangular jointless stems, a spiked inflorescence and long grass-like leaves which are usually rough on the margins and midrib. There are several hundred species.

Sediment Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks; it also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope soil characteristics, land usage and quantity and intensity of precipitation.

Sediment Load (1) The soil particles transported through a channel by stream flow. (2) The total sediment, including bedload plus suspended sediment load, is the sediment being moved by flowing water in a stream at a specified cross-section.

Seepage Slow water movement in subsurface. Flow of water from constructed retaining structures. A spot or zone, where water oozes from the ground, often forming the source of a small spring.

Sensory Disturbance Visual, auditory, or olfactory stimulus that creates a negative response in wildlife species.

Sensory Disturbance Visual, auditory or olfactory stimulus that creates a negative response in wildlife species.

Sentinel Species Species that can be used as an indicator of environmental conditions.

Seral Stage In an ecological succession, the series of biotic communities that follow one another on the way to the stable stage, or climax community.

Seven-Day 10-Year Low Flow (7Q10) The lowest average stream flow during a 7-day interval that is expected to occur once every 10 years on average.

Shadow population The people who live in work camps, campgrounds or hotels near Fort McMurray.

Shannon's Evenness Index (SHEI) Distribution of area among or within patch types in the landscape.

Shovel Test A subsurface test approximately 40 to 50 cm on a side excavated by hand to determine the presence/absence of buried cultural materials.

Silviculture The science and practice of controlling the establishment, composition and growth of the vegetation in forest stands. It includes the control or production of stand structures such as snags and down logs, in addition to live vegetation.

Sink Habitat A habitat within which reproductive and mortality rates should result in population declines. However, populations may be maintained in such habitat by immigration from nearby habitats that are more productive. The term was introduced by Pulliam (1988).

Slope Factor An upper-bound estimate of risk per increment of dose calculated using linear extrapolation for carcinogens.

Sodium Adsorption Ratio (SAR) The comparative concentrations of sodium, calcium and magnesium in the soil solution, where [Na^+], [Ca^{2+}] and [Mg^{2+}] are the concentrations in mmol of charge per litre of solution. The SAR of a soil extract takes into consideration that the adverse effect of sodium is moderated by the presence of calcium and magnesium ions. SAR values of 7 and higher cause dispersion of soils.

Soil The naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth.

Soil Heat Flux The soil heat flux constant is a function of the surface properties and is used to compute the flux of heat into the soil.

Soil Horizon A layer of mineral or organic soil material approximately parallel to the land surface that has characteristics altered by processes of soil formation. A soil mineral horizon is a horizon with 17% or less total organic carbon by weight. A soil organic horizon is a horizon with more than 17% organic carbon by weight.

Solar Radiation The principal portion of the solar spectrum that spans from approximately 300 nanometres (nm) to 4,000 nm in the electromagnetic spectrum. It is measured in W/m^2, which is radiation energy per second per unit area.

Solvent Aided Process Solvent aided process is an enhancement of steam assisted gravity drainage where a small amount of solvent (5 to 20% by mass) is added to the injected steam. When this steam solvent mixture contacts the reservoir, the oil in the reservoir drains faster as its viscosity is reduced due to both dilution and heating. This results in greater and faster recovery, improved economics, and reduced carbon dioxide (CO2) emissions from steam generation.

Sound Power Level (L_w) The level of sound power in decibels, of a sound is 10 times the logarithm to the base 10 of the ratio of the sound power to the reference power. The reference power shall be explicitly stated and is defined by standards; (commonly 1PW).

Sound Pressure Level (L_p) The level of sound pressure, in decibels, of a sound is 20 times the logarithm to the base 10 ratio of the sound pressure to the reverence pressure. The reference pressure shall be explicitly stated and is defined by standards; (commonly 20µPa).

Species A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.

Species Abundance The number of individuals of a particular species within a biological community (e.g., habitat).

Species Diversity A description of a biological community that includes both the number of different species and their relative abundance. Provides a measure of the variation in number of species in a region. This variation depends partly on the variety of habitats and the variety of resources within habitats and, in part, on the degree of specialization to particular habitats and resources.

Species Richness The number of different species occupying a given area.

Specific Storage The amount of water that an aquifer releases from storage per unit volume of aquifer per unit decline in hydraulic head while remaining fully saturated.

Spectral Sound Power Level	Spectral Sound Power Level in this Noise Assessment refers to the Sound Power Level at octave band centre frequencies from 31.5 Hz to 8000 Hz..
Sphagnum	A genus of peat-forming moss.
Sport/Game Fish	Large fish caught for food or sport (e.g., northern pike, Arctic grayling).
Spring Freshet	A spring thaw event resulting from melting snow and ice on rivers.
Stand Age	The number of years since a forest has been affected by a stand-replacing disturbance event (e.g., fire or logging) and has since been regenerating.
Standard Deviation (Sd)	A measure of the variability or spread of the measurements about the mean. It is calculated as the positive square root of the variance.
Steam Assisted Gravity Drainage (SAGD)	An in-situ oil sands recovery technique that involves the use of two horizontal wells, one to inject steam and a second to produce the bitumen.
Stratigraphy	The depositional layers within a site.
Stream Day	Maximum daily rate (design capacity for equipment).
Subhygric	Soil moisture conditions where water is removed slowly enough to keep the soil wet for a significant part of the growing season. There is some temporary seepage and possible mottling below 20 cm.
Subsoil	A stratum that includes one or more of the following: (i) that portion of the B horizon left after salvage of upland surface soil; (ii) the C horizon of an upland soil; (iii) underlying parent material at an upland location that is rated good, fair or poor as described in Table 9, Page 28 of the Soil Quality Criteria Relative to Disturbance and Reclamation,1987, as amended; and (iv) mineral material below an organic layer at a location other than upland, that is rated good, fair or poor as described in Table 9, Page 28 of the Soil Quality Criteria Relative to Disturbance and Reclamation,1987, as amended.

Substrate Material in the stream bed. The assemblage of material sizes include: Organic/Silt: organic material and/or fine material less than 0.006 mm diameter; Sand: material 0.06 to 2.0 mm diameter; Small Gravel: material 2 to 8 mm diameter; Large Gravel: material 8 to 32 mm diameter; Pebble: material 32 to 64 mm diameter; Cobble: material 64 to 256 mm diameter; and Boulder: material >256 mm diameter.

Succession A series of dynamic changes by which one group of organisms succeeds another through stages leading to a climax community.

Sulphur Dioxide Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, natural gas processing plants are responsible for close to half of the emissions of this gas. Oil sands facilities and power plants are also major sources. Others include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

SUM15 The sum of the daily $PM_{2.5}$ concentrations above 15 $\mu g/m^3$ throughout a calendar year, and is presented in units of $\mu g/m^3$ days

Surficial Aquifer A surficial (at or near the surface of the earth) deposit containing water considered an aquifer.

Surrogate Refers to the chemical selected to represent a group of related chemicals.

Surrogate Species A species that is well-known, easily sampled, often relatively abundant and whose conservation is presumed to provide for the needs of other species.

Suspended Sediments Particles of matter suspended in the water. Measured as the oven dry weight of the solids, in mg/L, after filtration through a standard filter paper. Less than 25 mg/L would be considered clean water, while an extremely muddy river might have 200 mg/L of suspended sediments.

Swamp Land having soils that are saturated with water for at least part of the year and which usually occur next to waterbodies or in areas in association with fluctuating water levels such as along peatland margins.

Synbit A piping mixture of bitumen with 50/50 blend of bitumen and synthetic crude oil.

Tailings A by-product of oil sands extraction typically comprised of water, sands and clays, with minor amounts of residual bitumen.

Tailings Ponds	Man-made impoundment structures required to contain tailings. Tailings ponds are enclosed dykes made with tailings and/or overburden materials to stringent geotechnical standards.
Taxa	A group of organisms of any taxonomic rank (e.g., family, genus, or species).
Terms of Reference	The Terms of Reference identify the information required by government agencies for an Environmental Impact Assessment.
Terrestrial Vegetation	Forested or non-forested areas of the landscape with non-saturated and non-peat forming soils. Excludes bogs, fens, swamps and marshes. (current definition) Land where soils are not saturated for extended periods of the year.
Thalweg	A line extending longitudinally along a watercourse following the deepest portion of the channel.
Threshold Chemicals	Chemicals that act via a threshold mechanism of action require a minimal concentration level to produce adverse effects. Below this specific threshold level, there is no potential for adverse effects to occur.
Threshold Limit Value (TLV)	The air concentration of a chemical below which workers may be repeatedly exposed day after day, without any occurrence of health effects. TLVs are recommended occupational exposure limits designed to control potential adverse effects associated with workplace exposure.
Till	Sediments laid down by glacial ice.
Timber Productivity Rating (TPR)	The potential timber productivity of a stand based on height and age of dominant and co-dominant trees of the leading species. The TPR reflects factors affecting tree growth including soil, topography, climate, elevation and moisture.
Toe	The location on the horizontally portion of a directionally drilled well that is farthest from the vertical portion of the drilled well. This location is at the maximum extent of the directionally drilled well.
Topsoil	Ae, Ah, Ahe, Ahj and gleyed and weakly gleyed versions of these horizons were usually considered to be part of the topsoil.

Total Core Area Index (TCAI)	A core area is an interior of a patch type that is within a given distance from the patch edge. This is the distance from a disturbance edge used to represent isolation from disturbance. It is used to represent the central portion of the natural area that is not part of the ecotone.
Total Dissolved Solids (TDS)	The total concentration of all dissolved compounds solids found in a water sample. See filterable residue.
Total Hydrocarbons (THC)	Total hydrocarbons include all airborne compounds containing only carbon and hydrogen.
Total Organic Carbon (TOC)	Total organic carbon is composed of both dissolved and particulate forms. Total organic carbon is often calculated as the difference between Total Carbon (TC) and Total Inorganic Carbon (TIC). Total organic carbon has a direct relationship with both biochemical and chemical oxygen demands, and varies with the composition of organic matter present in the water. Organic matter in soils, aquatic vegetation and aquatic organisms are major sources of organic carbon.
Total Petroleum Hydrocarbons	Groups of hydrocarbon chemicals derived from a petroleum source.
Total Reduced Sulphur (TRS)	A term used to collectively describe hydrogen sulphide and mercaptans.
Total Suspended Particulate	A term used to collective describe tiny airborne particles or aerosols that are less than 100 micrometres in size.
Total Suspended Solids (TSS)	The amount of suspended substances in a water sample. Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be artificial or anthropogenic wastes or natural sources such as silt.
Toxicant	A toxicant is a chemical compound that has an effect on organisms.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
Toxicity Assessment	The process of determining the amount (concentration or dose) of a chemical to which a receptor may be exposed without the development of adverse effects.

Toxicity Reference Value (TRV)	For a non-carcinogenic chemical, the maximum acceptable dose (per unit body weight and unit of time) of a chemical to which a specified receptor can be exposed, without the development of adverse effects. For a carcinogenic chemical, the maximum acceptable dose of a chemical to which a receptor can be exposed, assuming a specified risk (e.g., 1 in 100,000). May be expressed as a Reference Dose (RfD) for non-carcinogenic (threshold-response) chemicals or as a Risk Specific Dose (RsD) for carcinogenic (non-threshold response) chemicals. Also referred to as exposure limit.
Traditional Environmental (or Ecological) Knowledge (TEK)	Knowledge and understanding of traditional resource and land use, harvesting and special places.
Traditional Knowledge (TK)	Knowledge and understanding of traditional resource and land use, harvesting and special places.
Traditional Land Use (TLU)	Activities involving the harvest of traditional resources such as hunting and trapping, fishing, gathering medicinal plants and travelling to engage in these activities. Land use maps document locations where the activities occur or are occurring.
Traditional Resources	Plants, animals and mineral resources that are traditionally used by indigenous populations.
Traditional Use Plant Potential	A ranking system used to determine and map the relative abundance of traditional use plant species among different vegetation types or land cover classes within the landscape.
Traditional Use Plants	Plants used by aboriginal people of a region as part of their traditional lifestyle for food, ceremonial, medicinal and other purposes.
Transect	A method of sampling vegetation, along a path or fixed line.
Transmissivity	The product of the average coefficient of hydraulic conductivity (or permeability) and the thickness of the aquifer. Consequently, transmissivity is the rate of flow under a hydraulic gradient equal to unity through a cross-section of unit width over the whole thickness of the aquifer. It is designated by the symbol T. It has the dimension of: $Length^3/Time \times Length$ or $Length^2/Time$ (e.g., m^2/d).
Trophic	Pertaining to part of a food chain, for example, the primary producers are a trophic level just as tertiary consumers are another trophic level.

Trophic Status Eutrophication is the process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification or status: oligotrophic (nutrient poor), mesotrophic (moderately productive) and eutrophic (very productive).

Unconformably Two rock masses or strata of different ages separated by an erosional surface, indicating that sediment deposition was not continuous.

Understorey Trees or other vegetation in a forest that exist below the main canopy level.

Unemployment Rate Refers to the unemployed expressed as a percentage of the labour force in the week (Sunday to Saturday) prior to Census Day. Unemployed refers to persons 15 years and over, excluding institutional residents, who, during the week (Sunday to Saturday) prior to Census Day, were without paid work or without self-employment work and were available for work and either:

a) had actively looked for paid work in the past four weeks;

b) were on temporary lay-off and expected to return to their job; or

c) had definite arrangements to start a new job in four weeks or less.

Ungulate Species belonging to the order Artiodactyla (formerly Ungulata), and composed of the hoofed mammals. Horns or antlers are present on males and occasionally on females. In Alberta, there are three families represented by nine species, such as caribou, moose and deer.

United States Environmental Protection Agency (U.S. EPA) The U.S. EPA is responsible for implementing the federal laws designed to protect the environment. The U.S. EPA endeavours to accomplish its mission systematically by proper integration of a variety of research, monitoring, standard-setting and enforcement activities. As a complement to its other activities, the U.S. EPA coordinates and supports research and anti-pollution activities of state and local governments, private and public groups, individuals and educational institutions. The U.S. EPA also monitors the operations of other federal agencies with respect to their impact on the environment.

Upland Areas Areas that have typical ground slopes of 1 to 3% and are better-drainage.

Uplands Areas where the soil is not saturated for extended periods as indicated by vegetation and soils.

Vascular Plant Plants possessing conductive tissues (e.g., veins) for the transport of water and food.

Veneer Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10 cm to 1 m in thickness and possesses no form typical of the materials' genesis.

Volatile Organic Compounds (VOC) Volatile Organic Compounds include aldehydes and all of the hydrocarbons except for ethane and methane. VOCs represent the airborne organic compounds likely to undergo or have a role in the chemical transformation of pollutants in the atmosphere.

Water Table The shallowest saturated ground below ground level - technically, that surface of a body of unconfined groundwater in which the pressure is equal to atmospheric pressure.

Waterbody A general term that refers to ponds, bays, lakes, estuaries and marine areas.

Watercourse A general term that refers to riverine systems such as creeks, brooks, streams and rivers.

Watershed The area of land bounded by topographic features that drains water to a larger waterbody such as a river, wetlands or lake. Watershed can range in size from a few hectares to thousands of kilometres.

Weeds Plants that are defined as controlled weeds, nuisance weeds, or noxious weeds by the Weed Control Act, as amended.

Well Pad 1. The platform from which a hole or shaft is excavated, drilled, bored or cut into the earth so as to tap a supply of some material (e.g., water, oil, gas). 2. An area associated with Steam Assisted Gravity Drainage operations on which pairs of wells are drilled. The pairs of wells include a steam injection well and a production well.

Well Pair In steam assisted gravity drainage (SAGD) terms, a well pair consists of a horizontal production well that is drilled at or close to the base of the SAGD zone, and a horizontal injection well drilled the same length as, and approximately 5 m above, the producer. The injector injects steam into the SAGD zone, and the producer (using a specified lift system) produces emulsion (oil, condensed steam, and formation water) to the surface.

Wetlands Wetlands are land where the water table is at, near or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands," and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat.

Wildlife Wildlife is defined as a species, subspecies, variety or geographically or genetically distinct population of animal that is wild by nature and is native to Alberta or has extended its range into Alberta without human intervention and has been present in Alberta for at least 50 years.

Windrose A graphic tool used to depict how wind speed and direction are typically distributed at a particular location.

Wood Buffalo Environmental Association (WBEA) The mission of the Wood Buffalo Environmental Association is to monitor and provide accurate, credible, transparent and understandable information on air quality and air related environmental impacts in the Regional Municipality of Wood Buffalo.

Worst-Case A semi-quantitative term referring to the maximum possible exposure, dose or risk that can conceivably occur, whether or not this exposure, dose, or risk actually occurs or is observed in a specific population. It should refer to a hypothetical situation in which everything that can plausibly happen to maximize exposure, dose, or risk does happen. The worst-case may occur in a given population, but since it is usually a very unlikely set of circumstances in most cases, a worst-case estimate will be somewhat higher than what occurs in a specific population.

Xeric Soil moisture conditions where water is removed very rapidly in relation to supply. Soil is only moist for a very short time following precipitation.

Yearling An animal in its second year.

APPENDIX 2-1

TRADITIONAL LAND USE UPDATE

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1 EXECUTIVE SUMMARY

In December 2011, Canadian Natural Resources Limited (Canadian Natural) filed Applications and an Environmental Impact Assessment (EIA) with the Energy Resources Conservation Board (ERCB) and Alberta Environment and Sustainable Resource Development (ESRD) for the Kirby Expansion Project (the Project). Since submitting the EIA Canadian Natural offered Capacity Funding for the completion of Traditional Land Use (TLU)/Traditional Ecological Knowledge (TEK) studies to Chipewyan Prairie Dene First Nation (CPDFN), Heart Lake First Nation (HLFN), Whitefish Lake First Nation (Whitefish FN), Conklin Métis Local No. 193 (CML 193) Chard Métis Local No. 214 (Chard), Saddle Lake First Nation, Beaver Lake Cree Nation, Cold Lake First Nation, Willow Lake Métis and Fort McMurray First Nation, however to date Capacity Funding has only been accepted by CPDFN, HLFN, Whitefish FN and CML 193.

Since submission of the EIA, Canadian Natural has received TLU/TEK studies from:

- HLFN, provided in draft; and
- Whitefish FN.

The TLU/TEK studies provided by HLFN and Whitefish FN have identified traditional land use areas not previously considered in the Traditional Land Use Assessment, that may overlap with the Project footprint. However with the application of mitigation measures, the Project is not predicted to affect the identified traditional uses in the Local Study Area (LSA). Therefore, the information provided in the HLFN and Whitefish FN TLU studies do not change the assessment predictions in the EIA regarding effects to traditional hunting, trapping, fishing, traditional plant gathering and cultural sites.

2 INTRODUCTION

A Traditional Land Use Assessment was completed for the EIA using previous Traditional Land Use (TLU) studies, TLU assessments for other projects, and other regional reports. This information gave Canadian Natural an understanding of traditional land use in the Project Area. Since submission of the EIA Canadian Natural has received TLU/TEK studies from:

- HLFN, provided in draft; and
- Whitefish FN.

TLU/TEK studies are expected from CPDFN/Chard, who are working together to develop the TLU/TEK study (January 2013), and the Conklin Resource Development Advisory Committee (December 2012). Upon receipt of the TEK/TLU studies Canadian Natural will review the information provided and will work with each Aboriginal Group to identify and understand potential concerns and to develop suitable mitigation measures.

2.1 OBJECTIVES

The objectives of this TLU update are to:

- Review any newly identified traditional land use areas that may overlap with the proposed Project footprint to understand how these areas may alter the predictions presented in the Traditional Land Use Assessment (Volume 6, Section 2 of the December 2011 Application).
- Present the concerns raised in the TLU/TEK studies and Canadian Natural's response to the concern, including proposed mitigation measures and monitoring, where appropriate.
- Provide a summary of the information presented in the TLU/TEK studies.

The information presented in this TLU Update will also be shared with Aboriginal groups to further their understanding of the Project and its potential impacts on their traditional land use.

Canadian Natural will continue to consult with potentially affected Aboriginal Groups regarding the Project to understand potential concerns and appropriate mitigation measures.

3 HEART LAKE FIRST NATION TRADITIONAL LAND USE STUDY – DISCUSSION

To address the anticipated impacts identified in HLFN's TLU/TEK study, discussions on the assessment findings, mitigation measures and monitoring programs are provided in the following subsections where appropriate.

As noted above in Section 2.1, Canadian Natural will continue its on-going consultation with HLFN regarding the Project.

3.1 TRAPPING AND HUNTING

Information provided in the HLFN TLU/TEK study show that hunting and trapping areas (Figure 4.1.1 of the HLFN TLU/TEK study) may overlap with the proposed Project footprint. These areas were considered in the Traditional Land Use Assessment (Volume 6, Section 2 of the December 2011 Application [Canadian Natural 2012]). Canadian Natural recognizes that hunting is an activity that can occur over large areas and will work with HLFN to better understand the extent and use of the hunting areas identified and to discuss mitigation options to reduce potential effects to this traditional use, where required.

HLFN has identified the following concerns with regards to trapping and hunting:

- access restrictions to hunting/trapping;
- impacts to animal health; and
- impacts to Woodland Caribou, Movement Restrictions and Noise.

3.1.1 Access Restrictions

HLFN members raised concerns that the Project will result in access restrictions to the general Project Area and general development area for hunting / trapping by the HLFN people.

In the TLU/TEK Report HLFN identifies the area around Wiau Lake and the railway corridor as important for hunting and trapping. Access restrictions within the Project Area at this time are limited to the Central Processing Facilities (CPF). Canadian Natural does not have any current plans to restrict access to the area around Wiau Lake, the railway corridor or the general Project/development area, so HLFN will still have the opportunity to access these hunting and trapping areas. If the need for additional access restrictions is identified they will be implemented in consultation with ESRD and will consider information provided in HLFN's TLU/TEK study (Volume 6, Section 2.5.4.2).

Although access to the general Project/development area will not be restricted, discharge of a firearm will be prohibited in areas within the buffer of Project facilities. These areas however will remain available to use for access to hunting or trapping areas.

Canadian Natural consults with holders of Registered Fur Management Areas on lands where Canadian Natural is proposing Project facilities to understand their trapping activities and to avoid potential impacts where possible. Where avoidance is not possible, Canadian Natural will work with that trapper on compensation for direct damages.

3.1.2 Impacts to Animal Health

HLFN Elders are concerned that there may be contamination of animals trapped and hunted in their traditional territory (i.e., arsenic levels recently reported in moose of Northern Alberta).

As part of the EIA, Canadian Natural conducted a Screening Level Wildlife Risk Assessment (SLWRA; Volume 3, Appendix 3-14). Air emissions effects on wildlife (including avian wildlife) were considered in the Screening Level Wildlife Risk Assessment (SLWRA; Volume 3, Appendix 3-14). Air emissions can affect wildlife health indirectly through changes in habitat and through ingested soil and vegetation. This pathway was evaluated in the vegetation assessment and potentially affected wildlife habitat was considered as a subset of potentially affected vegetation. The SLWRA considered wildlife exposures to predicted maximum acute and chronic air concentrations and maximum soil concentrations. As described in the Surface Water Quality Assessment (Volume 4, Section 3), the Project is not expected to measurably change water quality in any of the nearby waterbodies. Therefore the potential effects on wildlife health based on changes in water quality were not included in the SLWRA for the Project. The results of the SLWRA indicated that the overall risks posed to wildlife health will be negligible. The confidence in the prediction is high since conservative assumptions were applied in the SLWRA.

3.1.3 Impacts to Woodland Caribou, Movement Restrictions and Noise

HLFN members report that they observe decreasing woodland caribou populations and want to understand what Canadian Natural is doing to minimize impacts to the populations.

HLFN also noted concerns regarding decreasing moose and caribou populations, which they attribute to the increasing number of fences and other movement restricting structures, along with an increase in noise and activity from industrial development.

3.1.3.1 Woodland Caribou

Canadian Natural is committed to reviewing Project development plans and access needs in relation to the presence of existing linear clearings and is committed to identifying opportunities for habitat restoration to offset Project impacts and benefit caribou (Volume 5, Section 4.5.1 of the Application and responses to Round 1 SIRs 199(a). 200(b), 204, 205 and 254(d))(Canadian Natural 2012). Canadian Natural's intent is to focus this effort within the Project Area (i.e., the Kirby oil sands leases) on Canadian Natural's existing oil sands related clearings (e.g., seismic lines) that may no longer be required for Project activities. Starting in 2013 Canadian Natural will be initiating an inventory of habitat restoration opportunities for Kirby South 2010 as part of the approved Wildlife Mitigation and Monitoring Plan for that project. Assuming the Kirby Expansion Project is approved in late 2013, the inventory of opportunities for the Kirby Expansion Project would start in 2014, and planning would occur over 2014 and 2015. Based on this inventory schedule, habitat restoration activities to offset Project impacts would begin in 2016.

Habitat reclamation approaches will also be applied to improve caribou habitat, and discourage access by predators. For example, jack pine stands, which provide habitat for caribou, will be one of the vegetation communities targeted for reclamation. Additional discussion of specific mitigations for caribou and efforts to minimize disturbance to caribou habitat are also provided in the response to Round 1 SIR 254.

Canadian Natural agrees that it has a role in the shared responsibility for caribou conservation under the Woodland Caribou Policy for Alberta (Government of Alberta 21011) and the recently released federal Recovery Strategy for the Woodland Caribou (Environment Canada 2012), and will contribute to the range-level planning and subsequent implementation that Canadian Natural understands will be forthcoming for the Cold Lake Caribou Range, as described in the response to Round 1 SIR 200b.

Canadian Natural will establish a wildlife monitoring plan to measure the effectiveness of mitigation, restoration of wildlife habitat, and the distribution and abundance of wildlife at the local scale, including federally and provincially-listed species. Canadian Natural will consult with ESRD during the development of the Project on the wildlife monitoring program. Wildlife monitoring information collected by Canadian Natural will be provided to ESRD to support regional wildlife management efforts. Additional details on the wildlife monitoring plan are provided in Volume 5, Section 4.6.

3.1.3.2 Movement Restrictions

As identified in Volume 5, Section 4.4.2.3 development can impede the movement of wildlife on a local and regional scale. Large disturbances (e.g., major infrastructure) as well as linear disturbances (e.g., above-ground pipelines and roads) can act as barriers to movement.

The Project effects on wildlife movement as a result of large and linear disturbances during construction and operation were assessed in the Wildlife Assessment (Volume 5, Section 4.4.2.3) and were predicted to be negligible to low for all wildlife KIRs (including moose) within the LSA and RSA except for caribou which was moderate for both the LSA and Regional Study Area (RSA). Post reclamation, the effects to wildlife movement were determined to be negligible for all wildlife, including caribou.

In addition to the mitigation identified in Section 3.1.3.1 for caribou, mitigation proposed by Canadian Natural to reduce Project effects on movement of wildlife during the design, construction, operations and reclamation stages of the Project are discussed in Volume 5, Section 1.6 and the response to Round 1 SIRs 205 and 254. The mitigation may include, among other measures, the use of wildlife crossing structures, under the pipe crossing opportunities on above-ground-pipelines, habitat restoration and reclamation. Existing Rights-of-Way (ROW) and disturbed areas will be used for access and installation of new infrastructure where possible to reduce direct habitat loss. Canadian Natural will endeavour to use common corridors and shared access with other resource users in the proposed Project Area to reduce the amount of new vegetation clearing and ground disturbance. In addition, the removal of the barriers to wildlife movement in the LSA after reclamation will result in the re-establishment of wildlife habitat, increasing wildlife habitat connectivity across the LSA and RSA.

To minimize the effects of linear disturbance from seismic activities as discussed in the response to Round 1 SIR 204, any future seismic surveys will be cut using low impact seismic techniques, including the minimization of duff and rooting layer disturbance. This approach improves the rate of natural regeneration of vegetation. Low impact seismic techniques also emphasize reduced line widths, wandering lines, avoidance cutting and line of sight breaks.

As noted in Section 3.1.3.1, Canadian Natural will establish a wildlife monitoring plan to measure the effectiveness of mitigation, restoration of wildlife habitat, and the distribution and abundance of wildlife at the local scale, including federally and provincially-listed species. Canadian Natural will consult with ESRD during the development of the Project on the wildlife monitoring program. Wildlife monitoring information collected by Canadian Natural will be provided to ESRD to support regional wildlife management efforts. Additional details on the wildlife monitoring plan are provided in Volume 5, Section 4.6.

3.1.3.3 Noise

Effects of noise on wildlife abundance are difficult to quantify. Little information is available regarding the long-term effects of sensory disturbance, and the effects to wildlife physiology and reproduction are difficult to observe and predict. However, after the implementation of mitigations as indicated in the Volume 5, Section 1.6, such as leaving vegetation intact around development areas, the environmental consequence due to potential sensory disturbance (e.g., noise) was rated low for moose and caribou at the LSA scale and negligible at the RSA scale (Volume 5, Table 4.4-1). Residual effects of sensory disturbance on Canada warbler, old growth forest bird community, rusty blackbird and yellow rail are predicted to have low environmental consequence at the LSA scale and negligible environmental consequence at the RSA scale. As stated above the effects of noise on wildlife are not well documented and are difficult to quantify, thus prediction confidence was rated as low.

3.2 FISHING

HLFN indicates that Wiau Lake and other lakes throughout the area represent a valuable source of fish for the community (Figure 4.2.1 of the HLFN TLU study). Wiau Lake was previously considered in the Traditional Land Use Assessment (Volume 6, Section 2). Canadian Natural will work with HLFN to better understand the extent and use of other lakes in the area and to discuss mitigation options to minimize potential effects to traditional fishing, where required.

HLFN has identified the following concerns with regards to fishing:

- increased access;
- impacts to watersheds from process water disposed to underground; and
- reclamation or avoidance of wetlands.

3.2.1 Increased Access

HLFN Elders identified concerns regarding increased access to fishing grounds. Canadian Natural acknowledges that the Project may result in increased access to certain lakes within the Local Study Area (i.e., Glover Lake and Edwards Lake), however the Project will not result in increased access to Wiau Lake (Volume 6, Section 2.5.4.2).

To mitigate potential increases in fishing pressure, Canadian Natural will prohibit staff and subcontractors from fishing in local lakes while staying at Project camps. Due to implementation of this policy, and based on the assumption that ESRD will provide appropriate management of sustainable fish populations, the Project should result in a negligible change in fishing pressure in the LSA.

3.2.2 Impacts to Watersheds from Process Water Disposed to Underground

The HLFN Elders expressed concern that watershed contamination could occur from the volumes of ‘unsuitable’ water returned to underground water sources.

The process wastewater injection wells for the Project will be constructed as per ERCB Directive 051: Injection and Disposal Wells (EUB 1994). Canadian Natural acknowledges that wastewater derived from bitumen processing operations is expected to have moderate to high levels of total dissolved solids, but disposal will be contained in saline reservoirs (where total dissolved solids are greater than 4,000 mg/l) such as the McMurray Formation Basal Aquifer and injected into salt caverns developed within the Devonian Prairie Evaporites.

Numerical particle tracking and analytical simulations indicate that subsurface migration of injected process wastewater within the McMurray Basal Aquifer will be horizontal and will be limited to hundreds of metres from the point of injection through the life of the Project (Volume 4, Section 5.5.3.5). Therefore, impacts to surface watersheds were not expected.

As part of the Project, Canadian Natural will install a groundwater monitoring network with the purpose to detect any changes to groundwater quality that could result from the Project. This groundwater monitoring network will be developed and constructed in consultation with, and will require approval from, ESRD.

Groundwater monitoring wells will be installed within shallow to deep, non-saline aquifers along the potential contaminant pathways between the potential sources and receptors. Wells will be installed upstream (relative to groundwater flow direction) of the potential contaminant sources (to determine local background groundwater quality) and will be installed downstream to monitor for any changes to groundwater quality. Monitoring wells will be installed and sampled prior to start-up of the Project operations in order to collect several background samples and to determine local groundwater quality variability (both spatial and temporal) under baseline conditions. Additional details of the groundwater monitoring plan can be found in Volume 1, Section 8.5.2, Volume 4, Sections 1.8.1 and 5.7 and in the response to Round 1 SIRs 128 and 234.

3.2.3 Reclamation or Avoidance of Wetlands

HLFN Elders believe that muskegs act as an invaluable natural filter that purifies water. They expressed concern that disturbance of wetlands will affect this ability to filter water, which will in turn affect the health of the water and fish gathered for consumption. The Elders have requested clarification on what Canadian Natural's plans are with respect to reclamation or avoidance of muskeg areas and what monitoring will be done throughout the life of the Project to ensure the health of the water in the vicinity of production facilities.

As identified in Volume 1 Section 11.5.3, siting of the Project facilities was completed using a constraints mapping process. Factors considered included:

- placing facilities to minimize disruption of wetlands drainage/flow;
- placing facilities on upland areas to minimize construction in wetlands where possible; and
- placing corridors to minimize crossings of wetlands.

Canadian Natural also considered the effects of the Project on wetlands in the Terrestrial, Vegetation, Wetlands and Forestry Assessment and concluded that the environmental consequences would be low and negligible at the LSA and RSA respectively (Volume 5, Section 3.4.5.1, Table 3.4-30). Canadian Natural also assessed the effects of the Project on wetlands hydrology in the Hydrology

Assessment and concluded that changes to wetlands hydrology as a result of the Project were negligible (Volume 4, Section 2.4.9).

It is Canadian Natural's intention to reclaim wetlands were possible. With respect to wetland reclamation in exhausted borrow areas and at the margins of well pads located in peatlands, in addition to following the *Conservation and Reclamation Guidelines for Alberta* and the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010), Canadian Natural will also refer to and follow and the *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (AENV 2008). These documents identify the target ecosite phases and wetland types that can be established on reclaimed landscapes and provides recommendations for successful reclamation practices. Reclamation will aim to restore self-sustaining vegetation communities that will be consistent with adjacent undisturbed vegetation and capable of supporting end land uses equal to or greater than those that existed prior to development (Volume 1, Section 11.10.2).

The baseline wetlands types and the target post reclamation wetland types in the LSA can be found in Volume 1, Figures 11.2-2 and 11.10-1.

Canadian Natural is participating in wetlands reclamation research trials through the University of Calgary and will consider the results of this and other similar research and evolving wetlands reclamation techniques when preparing the final reclamation plans for the Project.

Canadian Natural plans to conduct monitoring of wetlands affected by Project facilities and infrastructure (Volume 5, Section 1.7.2.2) as well as wetlands reclamation monitoring (Volume 5, Section 1.7.2.4). The details of this monitoring will be outlined in the Project wetlands monitoring plan which will be established following approval of the Project and in consultation with ESRD.

This wetlands monitoring program will consider monitoring information generated from the Wetlands Monitoring Program proposed, but not yet approved for Kirby South 2010. The Kirby South Wetlands Monitoring Program, as proposed, involves the monitoring of water levels, water chemistry and vegetation in wetlands up-gradient and down-gradient of representative well pads and roads to determine if the facilities are impeding water movement and affecting wetlands plant community structure and function. The monitoring will help to determine if mitigation (e.g., culverts under roads, ditching around well pads) is effective or if additional mitigation is required. The monitoring will also provide information for consideration during the design of future facilities that could affect wetlands.

Canadian Natural will conduct wetlands reclamation monitoring in accordance with the *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (AENV 2008). The performance assessment and monitoring recommendations contained in the guideline will be considered for incorporation into the post reclamation monitoring on wetlands areas. Information collected during wetlands reclamation monitoring for the Project will be used to inform further wetlands reclamation planning. Information collected from wetlands reclamation monitoring conducted at Canadian Natural's Primrose and Wolf Lake operations will also be considered as part of this process.

3.3 BIRDS/WATERFOWL

HLFN Elders did not provide specific information about the gathering of birds or waterfowl in the Project Area but did note that they see a decrease in avifauna biodiversity due to air pollution by industry and that the industrial noise from rigs and construction would likely cause them to find other areas to occupy.

The effects of the Project as well as other existing and approved developments on biodiversity were assessed at the species, ecosystem and landscape levels. The biodiversity species-level residual effect classification incorporates the residual effects predicted in the Terrestrial Vegetation, Wetlands and Forest Resources, and Wildlife and Wildlife Habitat Assessments (Volume 5, Sections 3.4 and 4.4, respectively). After Project construction, operations, and reclamation, the changes in biodiversity result in low residual environmental consequences in the LSA and negligible environmental consequences in the RSA at the species, ecosystem and landscape levels of biodiversity (Volume 5, Section 5.4.8, Table 5.4-13).

Canadian Natural will mitigate potential adverse effects of the Project on aspects of biodiversity as described in Volume 5, Section 1. The effectiveness of this mitigation at the Project scale will be determined through a wildlife mitigation and monitoring program (see Section 3.1.3.1 above). This program is expected to incorporate metrics that will allow for sharing of Project level data with regional biodiversity monitoring initiatives such as the Alberta Biodiversity Monitoring Institute (ABMI). If through the results of the monitoring program, it is determined the Project is having an adverse effect on species at the local level, Canadian Natural will work with regulators to define adjustments to mitigation, which, where possible, will reduce or eliminate these effects.

Biodiversity will also be factored in to reclamation planning for the Project. Final reclamation planning will solicit and incorporate input on aspects of biodiversity on reclaimed sites from a variety of stakeholders and Aboriginal groups (Volume 1, Section 11.12.2).

Noise and air quality and emissions are discussed in Sections 3.1.3.3 and 3.6, respectively.

3.4 BERRIES/MEDICINAL PLANT GATHERING

In the HLFN TLU study HLFN indicates that Wiau Lake, the area around Unnamed Lake 1 and the railway corridor are areas where berries and medicinal herbs were regularly gathered. These areas were considered in the Traditional Land Use Assessment (Volume 6, Section 2). To mitigate the potential impacts of the Project on gathering Canadian Natural has committed to maintaining a 200 m setback of Project facilities from Unnamed Lake 1. Canadian Natural will work with HLFN to better understand the extent and use of the gathering areas identified and to discuss additional mitigation options to reduce potential effects to this traditional use, where required.

3.4.1 Safety of Traditional Foods

HLFN Elders expressed concern about food safety and the impacts to plant life in the vicinity of the Project.

Potential effects to vegetation assessed by Canadian Natural included indirect dust effects, acid deposition, fumigation and nitrogen deposition from the Project. The assessment concluded that the residual effects on vegetation resources from Project dust, acid deposition, fumigation and nitrogen deposition were predicted to be negligible.

A Human Health Risk Assessment (HHRA) was completed for the EIA (Volume 3, Section 4) and assessed the health risks associated with multiple routes of exposure, including those related to water, fish, wild game, plants, berries and soil. The HHRA concluded that the Project is not expected to adversely affect the quality of any of the foods traditionally consumed by the Aboriginal communities in the area.

3.5 CULTURAL LAND USE – SACRED SITES/GRAVE SITES

Based on mapped cabin locations presented in the HLFN TLU study (Figure 4.6.1), there is one cabin owned by Eugene Monias and another owned by Curtis Monias that may be located near proposed Project infrastructure. These sites were not previously considered in the Traditional Land Use Assessment. Canadian Natural will work with HLFN to ground truth the locations of the cabins and if required, discuss mitigation options.

HLFN Elders requested clarification on whether field studies would be conducted to identify TLU sites and what Canadian Natural will do to avoid impacts to identified sites.

Canadian Natural conducted historic resources field studies under Permit 2011-269 from October 26 to November 1, 2011. Field work focused on the Project footprint outside of the areas previously surveyed for Kirby North 2010 and KS1. No new or previously identified archaeological or historic sites were found during the field studies; therefore avoidance measures are not required.

3.6 AIR QUALITY AND EMISSIONS

HLFN Elders have concerns about SO_2, NO_x and CO_2 emissions and their impacts on plants and wildlife. They also have concerns that these emissions can travel long distances and negatively affect ecosystems well beyond the Project Area.

The effects of acid deposition, fumigation (SO_2 and NO_2) and nitrogen deposition (eutrophication) on vegetation during construction and operation were discussed in Volume 5, Sections 3.4.4.3 to 3.4.4.5. Air emissions effects on wildlife (including avian wildlife) were considered in the Screening Level Wildlife Risk Assessment (SLWRA; Volume 3, Appendix 3-14). Air emissions can affect wildlife health indirectly through changes in habitat and through ingested soil and vegetation. This pathway was evaluated in the vegetation assessment and potentially affected wildlife habitat was considered as a subset of potentially affected vegetation. The environmental consequences of acid deposition, fumigation and nitrogen deposition were predicted to be negligible (Volume 5, Table 3.4-30).

The results of the SLWRA indicate that the overall risks posed to wildlife health will be negligible. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations and predicted maximum soil concentrations. The confidence in the prediction is high since conservative assumptions were applied in the SLWRA.

Results of the Air Quality Assessment are provided in Volume 3, Section 2.9. Maximum predicted SO_2 and NO_2 concentrations in the air LSA and for regional receptors, including the HLFN Reserve 167, are predicted to be below their AAAQOs for each case (Baseline, Application and Planned Development). Maximum predicted SO_2 and NO_2 concentrations for specific regional receptors are found in Volume 3, Appendix 3-4, Tables 4-29 and 4-30, respectively. The maximum predicted 1-hr, 24-hr, 30-day and annual SO_2 concentrations for the Application Case and Planned Development Case (PDC) occur near the Kirby North CPF.

Greenhouse gases (GHG), which include carbon dioxide, were addressed in Volume 3, Section 2.12. The estimated annual GHG emissions from the Project represent approximately 1.8% of Alberta's total annual GHG emissions and 0.6% of Canada's total annual GHG emissions. Canadian Natural's GHG emissions management plan will comply with the *Alberta Specified Gas Emitters Regulations*. In addition, Canadian Natural will participate in industry research and development projects that Canadian Natural believes will lead to positive environmental effects for its projects.

Canadian Natural has incorporated pollution abatement technologies into the Project design, including the reuse of produced gas, vapour recovery the reuse of tank vapours (Volume 1, Section 5). Canadian Natural is committed to complying with ERCB Interim Directive ID 2001-03; therefore, sulphur recovery requirements will be assessed once the Project is in operation and re-assessed periodically thereafter.

Canadian Natural will conduct monitoring of Project emission sources as specified in the *Environmental Protection and Enhancement Act* (EPEA) Approval. In addition, Canadian Natural is an active member of the Wood Buffalo Environmental Association and Lakeland Industry and Community Association.

3.7 DISPOSAL WATER

HLFN Elders are concerned that water returned to underground aquifers after industrial use may potentially contaminate other water sheds. Disposal water concerns are addressed in Section 3.2.2.

3.8 LAND SETTLING ISSUES

HLFN Elders are concerned about the long-term impacts of settling after the natural resources have been removed.

The potential for ground surface deformation due to thermal expansion is discussed in Volume 5, Section 2.4.4. Given the reservoir depth and the low operating pressure, a maximum heave of 15 cm and heave slope of 0.015% were estimated as a result of the Project (response to Round 1 SIR165c). Data was reviewed from other operating projects and has indicated that the deeper the reservoir, the smaller the amount of surface heave and the shallower the heave slope at the ground surface. The reservoir depth at the Project will be greater than the projects Canadian Natural reviewed. The Project will also be operated under lower pressure and lower temperature than the operating projects reviewed (response to Round 1 SIR 2).

Given the small expected magnitudes and slow deformation rates of ground heave due to Steam Assisted Gravity Drainage (SAGD) processes, terrain changes and natural drainage patterns are anticipated to adapt to changes and minimal alterations in local or sub-basin water flow directions are expected, and will be confined locally to the area where subterranean steam injection is to occur. The environmental consequences of ground heave are expected to be negligible in the LSA and RSA. The prediction confidence for ground heave is high. Additionally, Canadian Natural believes the surface heave will decline over time as the reservoir cools naturally.

3.9 LAND TRANSFORMATION – LINEAR DISTURBANCE AND ACCESS

HLFN Elders note their concerns that habitat fragmentation from linear infrastructure can reduce the amount of wildlife available and the movement patterns of wildlife and birds in the region. They also note their concern that there is increased activity of non-native hunters in the area and recreational uses.

Potential effects of linear disturbance are discussed in Section 3.1.3.2.

As Project development results in new clearings, access to the land for some resource uses may improve during the life of the Project. Canadian Natural acknowledges that increased access may result in increased activity and recreational uses of non-native hunters, however the Resource Use Assessment indicates that non-Aboriginal use of the access in the LSA is likely low due its distance from larger centres within and outside the Resource Use RSA (Volume 6, Section 3.6.1.3).

Proposed mitigation measures to address potential impacts from increased access include:

- Shared access will be used wherever possible. New clearings will be minimized by sharing space with utility corridors where possible.
- Careful consideration will be given to alternate routes before re-opening existing lines that are starting to regenerate.

With the implementation of these mitigation measures the potential effects relating to access will be reduced. The implementation of mitigation measures results in a negligible environmental consequence for beaver, Canada Lynx and woodland caribou at both the LSA and RSA scales (Volume 5, Section 4.4.2.1).

To protect wildlife from changes in access, Canadian Natural may use roll backs along ROW no longer used for the Project as a means to control access at various times. A roll back is an access control method used on winter access roads, pipelines, seismic lines where cut timber is rolled back or placed on the opened access to prevent motorized vehicle travel. Usually the timber is spread back at the start of the road for approximately 100 to 150 m.

3.10 OVER-PRESSURIZATIONS AND FRACTURING OF THE SURFACE

HLFN Elders note concern about the extensive amount of pressure pumped into the site and the impact of the surface structure.

Suitable caprock has been identified over the proposed SAGD reservoirs in the Regional Study Area (Volume 1, Section 3.8.3.2). Canadian Natural will operate at pressures low enough to maintain caprock integrity. The response to Round 1 SIR 21 provides a discussion of the maximum operating pressures required for the Project, and the composition of the caprock which demonstrates the integrity of the caprock.

Canadian Natural will implement an instrumentation and control system for the steam injection well of each SAGD well pair which will include a steam volumetric flow rate set point and an injection pressure set point (Volume 1, Section 3.8.4). The automated system will monitor and adjust steam injection pressure and volumetric flow rate such that the set points are not exceeded. In addition, if the set points are exceeded, alarms will be triggered and operators will initiate a timely and appropriate response. This control strategy is the same as that currently employed by Canadian Natural for its newer SAGD well pairs at Wolf Lake.

3.11 VOLUME OF WATER USED AND LOST

Heart Lake First Nations Elders are concerned about the volume of groundwater withdrawn to produce steam.

Canadian Natural seeks to ensure water is used efficiently in its operations (Volume 1, Section 6). The overall water source plan for the Project was developed based on the following principles for boiler feed water and make-up water sourcing:

- maximize produced water recycle;
- minimize disposal;

- maximize saline water use; and
- minimize non-saline water use.

To generate steam, Canadian Natural plans to use a combination of produced water and groundwater from deep aquifers (i.e., greater than 200 m in depth). The majority of the water used for steam generation during operation will come from recycled produced water (>90%). The remainder will be sourced from deep saline and non-saline groundwater, with most of this make-up water coming from saline groundwater sources. All wells used for the withdrawal of non-saline groundwater will be licensed under the *Water Act* (AENV 2000) and will be operated within quantitative regulatory limits over the Project life (AENV 2006).

The use of evaporative steam generation technology in the Project is consistent with the water treatment technology approved for use at Kirby South 2010 and will maximize produced water recycle and minimize disposal. Canadian Natural fully expects the Project to meet all water efficiency metrics required by ERCB directives.

3.12 RECLAMATION

HLFN Elders expressed their concern that the reclaimed landscape will lack the biodiversity of its pre-disturbance state. They feel there is significant uncertainty about the long-term stability of created landforms, the long-term performance and survival of native vegetation species, and the ability to restore landscape biodiversity. HLFN Elders expressed concerns around the lack of microscopic organisms that create a healthy ecosystem.

As discussed in Volume 1, Section 11.12.2, biodiversity will be factored into reclamation planning for the Project. Final reclamation planning will solicit and incorporate input on aspects of biodiversity on reclaimed sites from a variety of stakeholders and Aboriginal groups.

Information sources Canadian Natural will consider during reclamation include: Information from Aboriginal Groups, *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010), which includes information from the *Fort McKay First Nation, Sagow Pimachiwin: Plants and Animals Used by Mikisew Cree First Nation for Food, Medicine and Materials* (MCFN GIR 2011) and the planting prescriptions in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010), which includes certain traditional use plant species. The reclamation procedures and the planting prescriptions are used to re-establish ecosite phases that support the growth of traditional use plants. Further details on wetlands reclamation can be found in Section 3.2.3 above.

As noted in the response to Round 1 SIR 186, Canadian Natural acknowledges that there are uncertainties concerning reclamation material characteristics after mixing topsoils over several years, which may lead to changes in texture, nutrients, and water holding capacity and volume, among other characteristics. The reclaimed landscape may have variances in topography. Re-contouring is intended to be random and pocketed in reclaimed landscapes to create topographic diversity so there may be a variety of areas of different land capability in a Project Area, although the soil placement is the same across the entire site.

Canadian Natural will implement a monitoring program upon completion of reclamation activities on each reclaimed site (Volume 1, Section 11.13). The objectives of the monitoring program are to evaluate the success of conservation and reclamation (C&R) activities over time and to adjust or modify reclamation practices, where necessary, to achieve reclamation targets and, ultimately, obtain a reclamation certificate. Reclamation monitoring will comply with the EPEA Approval and will include evaluation of:

- erosion control, vegetation cover and slope stability monitoring for all affected sites including ditches, soil stockpiles and windrows;
- soil quality;
- revegetation (transplantation and reseeding success) and ecosystem development on reclaimed areas;
- effectiveness of noxious and restricted weed control during and after operations on a regular basis;
- return of equivalent land capability for forestry;
- the success of natural regeneration; and
- re-establishment of wildlife habitat.

4 WHITEFISH LAKE FIRST NATION TRADITIONAL LAND USE STUDY – DISCUSSION

To address the anticipated impacts identified in Whitefish FN's TLU/TEK, discussions on the assessment findings, mitigation measures and monitoring programs are provided in the following subsections. As noted in Section 2.1 above, Canadian Natural will continue its on-going consultation with Whitefish FN regarding the Project.

4.1 AIR QUALITY

Whitefish FN members have identified the following concerns with regards to air quality:

- emissions during construction and operations;
- emissions from burning organic debris during clearing for any pipeline right of ways, central processing facilities and well pads;
- dust generated during construction; and
- noise from construction vehicles, noise from construction activities including clearing, blasting, drilling and pipeline installation activities and noise during operations and maintenance.

4.1.1 Emissions During Construction and Operations

The effects of acid deposition, fumigation (SO_2 and NO_2) and nitrogen deposition (eutrophication) on vegetation during construction and operation were discussed in Volume 5, Sections 3.4.4.3 to 3.4.4.5 of the December 2011 Application (Canadian Natural 2011). The environmental consequences of acid deposition, fumigation and nitrogen deposition were predicted to be negligible for terrestrial vegetation, wetlands and forestry assessment (Volume 5, Table 3.4-30). The effects of air emissions on surface water quality were addressed in Volume 4, Section 3.6.3. The environmental consequence of acidification and episodic acidification on surface water quality was predicated to be negligible.

Air emissions effects on wildlife (including avian wildlife) were considered in the Screening Level Wildlife Risk Assessment (SLWRA; Volume 3, Appendix 3-14). Air emissions can affect wildlife health indirectly through changes in habitat and through ingested soil and vegetation. This pathway was evaluated in the vegetation assessment and potentially affected wildlife habitat was considered as a subset of potentially affected vegetation. The results of the SLWRA indicate that the overall risks posed to wildlife health will be negligible. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations and predicted maximum soil concentrations. The confidence in the prediction is high since conservative assumptions were applied in the SLWRA.

Results of the Air Quality Assessment are provided in Volume 3, Section 2.9. Maximum predicted SO_2 and NO_2 concentrations in the air LSA and for regional receptors, including Whitefish (Goodfish) Lake First Nation #128, are predicted to be below their AAAQOs for each case (Baseline, Application and Planned Development). Maximum predicted SO_2 and NO_2 concentrations for specific regional receptors are found in Volume 3, Appendix 3-4, Table 4-29 and Table 4-30, respectively. The maximum predicted 1-hr, 24-hr, 30-day and annual SO_2 concentrations for the Application Case and PDC occur near the Kirby North CPF.

Diesel emissions from vehicles used for the construction and reclamation activities contributed to greenhouse gas (GHG) emission predictions. During the construction and decommissioning phases of the Project, GHG emissions will be primarily from the gasoline and diesel vehicles used. Project GHG emissions during the operation phase will be primarily from natural gas and produced gas combustion (i.e., steam generators and heaters). A summary of GHG emissions for the three phases of the Project are presented in Volume 3, Table 2.7-13. The Project's contribution (at full build) to provincial and national annual GHG emissions is presented in Volume 3, Table 2.7-15. The estimated annual GHG emissions from the Project represent approximately 1.8% of Alberta's total annual GHG emissions and 0.6% of Canada's total annual GHG emissions. Canadian Natural's greenhouse gas emissions management plan will comply with the *Alberta Specified Gas Emitters Regulations*. In addition, Canadian Natural will participate in industry research and development projects that Canadian Natural believes will lead to positive environmental effects for its projects. .

Canadian Natural has incorporated pollution abatement technologies into the Project design, including the reuse of produced gas, vapour recovery the reuse of tank vapours (Volume 1, Section 5). Canadian Natural is committed to complying with ERCB Interim Directive ID 2001-03; therefore, sulphur recovery requirements will be assessed once the Project is in operation and re-assessed periodically thereafter.

Canadian Natural will conduct monitoring of Project emission sources as specified in the *Environmental Protection and Enhancement Act* (EPEA) Approval. In addition, Canadian Natural is an active member of the Wood Buffalo Environmental Association and Lakeland Industry and Community Association.

4.1.2 Emissions from Burning Organic Debris During Clearing for Any Pipeline Right of Ways, Central Processing Facilities and Well Pads

All woody debris will be burned or mulched in accordance with regulations (ESRD 2009). The majority of woody debris will be piled and burned. Debris disposal by burning will adhere to the recommendations set out in the ESRD FireSmart Guidebook (ESRD 2008). The ESRD web site will also be consulted to monitor the most current conditions and requirements for both summer and winter burning activities to ensure burning occurs under suitable conditions (Volume 1, Section 11.8.2.2).

4.1.3 Dust Generated During Construction

Potential effects to vegetation assessed by Canadian Natural include indirect dust. Indirect effects of dust associated with the Project are expected from increased vehicle activity on roads and associated infrastructure in and around the Project Area (Volume 5, Section 3.4.4.2). The primary effects of dust are generally confined to the immediate area next to roadways (Everett 1980; Walker and Everett 1987). To reduce the effects of dust to vegetation, Canadian Natural will control dust from roads during dry conditions in the spring, summer and fall. Reclamation will help to mitigate the indirect effects from dust on vegetation as vehicle activity will decrease when operations cease. Dust is predicted to have a low environmental consequence on vegetation resources in the LSA.

4.2 NOISE

As reported in Volume 3, Section 3.4.51, noise due to construction is temporary; the activities are variable and move between the facilities and the well pad locations. While more variable, construction noise is expected to be less than operations noise overall, as construction will require fewer major noise sources. The variability of noise emission levels and locations over different construction phases will result in a wide range of noise levels at receptors. A discussion on the timing of various construction activities is presented in Volume 3, Section 3.2.3. The noise levels during the worst-case year discussed in Volume 3, Section 3.2.3 is expected to be around 28 dBA, which will change the existing background noise levels by less than 0.8 dBA.

If there is a noise concern raised during construction activities Canadian Natural will implement the following mitigation measures where appropriate and practical:

- conduct construction activity between the hours of 07:00 a.m. to 10:00 p.m. to reduce the potential effects of construction noise;
- advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption;
- ensure that all internal combustion engines are fitted with appropriate muffler systems; and
- take advantage of acoustical screening from existing on-site buildings to shield dwellings from construction equipment noise.

Once the Project is operational, noise will be of a continuous nature for the approximately 20-year operational lifespan of the Project. Operational noise will be due to continuously operating equipment. During infrequent emergency upset conditions, louder noises may be produced by steam blow-downs and flaring but these will be of short duration. The noise assessment evaluated the potential noise levels over the approximate production life of 20 years by evaluating a worst-case noise condition. This worst-case condition represents the highest expected continuous noise levels over the life span of the Project, and assumes that:

- Project facilities are fully operational;
- all facilities are developed simultaneously; and
- all facilities are operating for the full operational life.

The Project will include design features and best practices that will provide noise mitigation including:

- processing equipment will be housed within buildings;
- building exterior doors will be closed and properly sealed;
- building/enclosure ventilation openings will feature ventilation louvers and vent hoods;
- fixed equipment will include noise control where applicable to meet Alberta Occupational Health and Safety Code design requirements; and
- mobile equipment will be equipped with standard silencers/mufflers.

Effects of noise on wildlife abundance are difficult to quantify. Little information is available regarding the long-term effects of sensory disturbance, and the effects to wildlife physiology and reproduction are difficult to observe and predict. However, after the implementation of mitigations as indicated in the Volume 5, Section 1.6, such as leaving vegetation intact around development areas, the environmental consequence due to potential sensory disturbance (e.g., noise) was rated low for moose and caribou at the LSA scale and negligible at the RSA scale (Volume 5, Table 4.4-1). Residual effects of sensory disturbance on Canada warbler, old growth forest bird community, rusty blackbird and yellow rail are predicted to have low environmental consequence at the LSA scale and negligible environmental consequence at the RSA scale. As stated above the effects of noise on wildlife are not well documented and are difficult to quantify, thus prediction confidence was rated as low.

4.3 GROUNDWATER

Whitefish FN members are concerned about changes to discharging and recharging patterns and possible obstruction of flow.

Project activities that could result in changes to the groundwater flow regime and/or changes to groundwater/surface water interaction include extraction of groundwater for plant processing and utility use (Volume 4, Table 5.2-4). These potential effects were addressed in the Hydrogeology Assessment (Volume 4, Section 5).

To generate steam, Canadian Natural plans to use a combination of produced water and groundwater from deep aquifers (i.e., greater than 200 m in depth). The majority of the water used for steam generation during operation will come from recycled produced water (>90%). The remainder will be sourced from deep saline and non-saline groundwater, with most of this make-up water coming from saline groundwater sources. All wells used for the withdrawal of non-saline groundwater will be licensed under the *Water Act* (AENV 2000) and will be operated within quantitative regulatory limits over the Project life (AENV 2006).

As part of the EIA, Canadian Natural constructed a numerical groundwater flow model to help predict the degree of effect, if any, on shallow groundwater aquifers and surface water due to the withdrawal of deep groundwater. The EIA considered groundwater withdrawals from other existing and approved projects. The results of this analysis are found in Volume 4, Sections 5.5.2 and 5.6.1. The effects on shallow aquifers and surface water were predicted to be of low environmental consequence because the drawdown effect when propagated vertically would be low in magnitude and the effect would be reversible once groundwater pumping ceases. The changes in groundwater quantity and flow were also predicated to be negligible.

As discussed in Volume 1, Section 8.5.2 and Volume 4, Section 1.8.1, Canadian Natural will develop and implement a groundwater monitoring program in consultation with ESRD following Project approval and prior to Project start-up. This monitoring program will help further Canadian Natural's understanding of groundwater flow regime in the well pad development areas.

Linkages of the Project water use to potential effects on aquatic and riparian habitat were considered. With the exception of the linkage between groundwater use and surficial aquifer drawdown (and associated vegetation effects on land cover types, in particular wetlands), all linkages that were assessed were determined to be invalid and assessment of the potential effects was therefore not necessary. Aquifer drawdown was predicted to have low environmental consequence to vegetation land cover types (Volume 5, Section 3.4.5).

Mitigation that will be implemented during Project construction and operations to minimize or eliminate impacts to aquatic resources is discussed in Volume 4, Section 1.7. Specific mitigation with regards to groundwater withdrawal includes operation of all wells in accordance with licenses to ensure drawdown effects are within acceptable limits. Mitigation is incorporated into the assessments of potential effects considered in the EIA.

Possible obstruction of surface water flow is addressed below in Section 4.4.3.

4.4 HYDROLOGY

Whitefish FN members identified the following concerns with regards to hydrology:

- withdrawals from the water table during construction, resulting in decreased water quantity and impacts to drinking water supply;
- increased sedimentation and turbidity;
- possible obstruction of flow;
- changes in peak flows causing bank instability and alteration of drainage patterns causing instability; and
- changes to water temperature.

4.4.1 Withdrawals from the Water Table during Construction Resulting in Decreased Water Quantity and Impacts to Drinking Water Supply

Water will be withdrawn from surface waterbodies for suppression of road dust, construction of ice roads and ice pads, and drilling of wells, as discussed in the Hydrology Assessment (Volume 4, Section 2.4.7). Canadian Natural does not plan to use surface water from waterbodies or watercourses for operations (process) purposes. As identified in the response to Round 1 SIR 149a (Canadian Natural 2012) the estimated maximum Project water use of 199,000 m^3/year is less than 1% of the estimated annual runoff in the Aquatic Resources LSA (129,000,000 m^3/year) and less than the estimated 3,000,000 m^3/year of increased runoff due to the Project. Canadian Natural will apply to ESRD for *Water Act* temporary diversion licences (TDLs) to permit the withdrawals. The withdrawal locations and limits to volumes of water that can be withdrawn at each location will be specified in the TDLs. Canadian Natural will adhere to these restrictions. Due to naturally occurring low winter flow volumes, watercourses would be unlikely to provide sustainable sources for surface water withdrawals. Therefore, surface water withdrawals are planned from waterbodies. Based on the relatively small volumes of these surface water withdrawals, and their localized and temporary nature, the Hydrology Assessment for the Application Case predicted the environmental consequence to hydrology to be negligible (Volume 4, Section 2.4.9).

As a result, Canadian Natural does not expect that the Project will affect the water needs of Aboriginal communities in the vicinity of the Project, with the closest community being 10 km from the proposed Project Area.

4.4.2 Increased Sedimentation and Turbidity

The Project facilities have the potential to affect sediment yields, and sediment and suspended sediment concentrations (turbidity) in receiving streams, lakes, ponds and wetlands through the following mechanisms:

- Disturbed surfaces have the potential to generate higher sediment loads in surface runoff than undisturbed surfaces.
- Increased runoff from disturbed areas has the potential to increase flow rates in receiving streams and thereby increase in-stream erosion (geomorphic changes).
- The disturbance of the bed and banks of stream channels during construction of road and pipeline crossings and during decommissioning

and reclamation activities has the potential to increase erosion, resulting in additional sediment loads to the streams.

Canadian Natural's assessment determined that the overall environmental consequence of suspended sediments from disturbed surfaces to surface water quality and hydrology will be negligible (Volume 4, Section 2.4.9).

Given the use of common industry codes of practice and the proposed mitigation (Volume 4, Section 1.7), the environmental consequence of suspended solids at watercourse crossings (e.g., road and pipeline crossings) on surface water quality and hydrology is considered to be negligible.

4.4.3 Possible Obstruction of Flow

As per Volume 4, Section 1.8.2.2, Canadian Natural acknowledges that excessive sedimentation, debris or ice accumulation in culverts can obstruct flow. Watercourse crossings will be monitored to identify any obstructions and to determine the locations are stable and that potential erosion and sediment following construction are minimal. The monitoring program will include the following:

- Culvert installations at road crossings will be inspected. Excessive sedimentation, debris or ice accumulation will be removed to maintain the flow capacity of the culvert. Screens may be added to culvert inlets to prevent blockage in areas of potential beaver activity.
- Watercourse crossings will be inspected to confirm that properly installed sediment control measures are in place during and following construction.
- Post-construction inspection will be undertaken to verify that affected streambed profiles and banks have been appropriately reclaimed.

4.4.4 Changes in Peak Flows Causing Bank Instability and Alteration of Drainage Patterns Causing Instability

Watercourse flow and water level changes during high flow conditions were evaluated in Volume 4, Section 2.4.2 and the potential for geomorphic change was evaluated in Volume 4, Section 2.4.5.2. The environmental consequences for peak flow water levels were considered to be negligible. Geomorphic change is local and generally occurs during peak flow periods and thus is short term and infrequent. Geomorphic change, however, is reversible and thus the overall consequence of the change in sediment transport due to geomorphic change was considered to be negligible. Peak flows are within the range of natural variation and geomorphic effects will also be in this natural variation range.

4.4.5 Changes to Water Temperatures

Canadian Natural assessed the potential influence of groundwater temperature increase from steaming operations on surface watercourses and waterbodies in Volume 4, Section 3.4.2. Based on the assessment Canadian Natural concluded that the magnitude of the environmental effect to surface water quality due to heating from SAGD wells is considered to be low for horizontal heat migration from steam and production well risers and negligible for vertical heat migration from the steam chamber. For horizontal flow the resulting environmental consequence is negligible. The assessment is based on observations at operating SAGD sites recognizing variations in local geology. As a result, the confidence in the prediction is considered moderate (Volume 4, Section 3.4.2).

4.5 WATER QUALITY

Whitefish FN members identified the following concerns with regards to water quality:

- leaks and/or spills; and
- erosion and sedimentation.

4.5.1 Contamination Caused By Leaks and/or Spills

Canadian Natural acknowledges that the potential exists for leaks and/or spills to occur during construction and operation. Proactive planning to prevent releases of liquids including crude bitumen, industrial chemicals and/or produced water will be a high priority for the Project. Canadian Natural and its contractors will engage in good housekeeping practices and active maintenance and monitoring at the central processing facilities (CPFs), steam assisted gravity drainage (SAGD) well pads and Project facilities to prevent, correct and clean up small leaks, accidental spills or releases.

Canadian Natural will apply its corporate Environmental Management and Operating Guidelines, which will include an Emergency Response Plan and specific programs for spill response and fire management (Volume 1, Section 8.4.3). Contingency plans and emergency response plans will be prepared to address leaks and spills. All facilities will be located on compacted clay pads and clean-up will be completed in a timely manner to minimize infiltration through the underlying soil. Canadian Natural will report spills to ERCB and ESRD as required.

The potential impacts of leaks and spills were assessed as part of the Surface Water Quality Assessment and determined to have a low environmental consequence to surface water quality (Volume 4, Section 3.4.4). The Aquatic Ecology Assessment considered potential impacts on fish habitat due to leaks and spills and concluded that the environmental consequence will be negligible (Volume 4, Section 4.4.2.3).

4.5.2 Degraded Surface Water Quality through Erosion and Sedimentation

Surface water quality and sedimentation concerns are addressed in Section 4.4.2.

4.6 SOILS

Whitefish FN members identified the following concerns with regards to soils:

- surface disturbances during construction resulting in erosion and/or other instabilities;
- subsurface soil changes in temperature;
- decrease in productive capacity of soil due to removal, contamination, and/or topsoil and subsoil mixing;
- soil sloughing making re-establishment of vegetation difficult; and
- stripping, grading, excavation and backfilling leading to terrain instability.

4.6.1 Surface Disturbances during Construction Resulting In Erosion and/or Other Instabilities

Erosion due to the Project affects only areas that will be disturbed by construction (local geographical extent), which is less than 10% of the LSA. The total area of soils with high erosion potential in the LSA is 12%; however, most of these areas do not occur within the Project footprint. Canadian Natural believes that although the potential does exist for erosion, implementation of mitigation measures will reduce the extent and severity of erosion. For example, drainage control measures will be installed during construction and maintained to manage runoff and areas with erosion potential will be protected with measures such as seeding with an ESRD-approved seed mix (Volume 1, Table 11-7.1), or placing erosion matting, mulch or silt fencing (Volume 1, Section 11).

The resulting environmental consequence for erosion due to the Project is low in the LSA and negligible in the RSA. The prediction confidence for erosion is high (Volume 5, Section 2.4.3).

4.6.2 Subsurface Soil Changes in Temperature

Thermal in situ oil sands operations are typically not expected to result in changes to subsurface soil temperatures. Accordingly soil properties are not expected to be altered and effects on the establishment, growth and reproduction of vegetation is not anticipated.

4.6.3 Decrease in Productive Capacity of Soil Due To Removal, Contamination, and/or Topsoil and Subsoil Mixing

Canadian Natural's plans for topsoil, subsoil and organic soil salvage for the Project are discussed in Volume 1, Section 11.8.3. As part of these plans Canadian Natural will be stockpiling topsoil and subsoil separately to prevent mixing and will be using a qualified environmental specialist to monitor soil salvage operations in the field to advise equipment operators on variations in salvage depths and to specify what depths should be salvaged. To prevent contamination of stockpiled soil, stockpiles will be located on a stable surface where surface runoff from the surrounding area does not pool around the base of the stockpiles.

With the implementation of these and additional mitigation measures, as identified in Volume 1, Section 11, Canadian Natural does not anticipate there will be effects to the productive capacity of soil due to removal, contamination and/or topsoil and subsoil mixing.

4.6.4 Soil Sloughing Making Re-Establishment of Vegetation Difficult

As discussed in Section 4.6.1 the environmental consequence of erosion (or soil sloughing) was rated as low. Canadian Natural will implement the mitigation measures and monitoring identified in Volume 1, Section 11 to ensure successful re-establishment of vegetation during reclamation.

4.6.5 Stripping, Grading, Excavation and Backfilling Leading to Terrain Instability

Project activities that will result in the direct loss or alteration of terrain in the LSA include site clearing and surface disturbance during construction and operations (Volume 5, Table 2.4-2). Facility construction generally includes the placement of construction fill materials, which may alter the surface expression and slopes compared to the pre-development landscape. This earthworks construction may also alter the site drainage patterns at the local scale. Since the topography of the LSA varies from level to rolling, cut and fill will be necessary in constructing facilities. Therefore, changes to terrain for both wetlands and uplands terrain are included in the Terrain and Soils assessment. Canadian Natural will recontour disturbed sites, as necessary, to restore natural drainage patterns and topography, and to ensure that the reclaimed terrain is compatible with the surrounding terrain.

Loss and alteration of wetland terrain is rated as a low environmental consequence (negative direction) while loss and alteration of upland terrain was rated as a negligible environmental consequence (Volume 5, Section 2.4.5).

4.7 FISH AND FISH HABITAT

Whitefish FN have identified the following concerns with regards to fish and fish habitat:

- water temperature changes affecting sensitive fish and habitats;
- increased turbidity and sedimentation leading to species loss;
- decreased aquatic vegetation for food and habitat;
- decreased aquatic biodiversity, as stronger species out-compete more sensitive species;
- increased sport fishing activity as access is opened up;
- potential for blocked fish passage if culverts are installed incorrectly;
- contamination from spills and/or leaks; and
- fluctuating water levels.

4.7.1 Water Temperature Changes Affecting Sensitive Fish and Habitats

As noted above in Section 4.4.5, changes to surface water temperatures due to Project activities are not expected; therefore effects to fish and fish habitat from water temperature changes are not expected.

4.7.2 Increased Turbidity and Sedimentation Leading To Species Loss

As noted above in Section 4.4.2, the environmental consequence of sediment and suspended sediment (turbidity) concentrations is negligible for surface water quality and hydrology therefore effects to fish and fish habitat are not expected.

4.7.3 Decreased Aquatic Vegetation for Food and Habitat

As described in Volume 1, Section 11.5.3, siting of the Project facilities was completed using a constraints mapping process that took into consideration environmental constraints, including traditional use areas identified during consultation with Aboriginal groups. In consideration of these constraints Canadian Natural's Project facilities were planned with a 100 m setback from the edge of watercourses/waterbodies and 200 m setback from Unnamed Lake 1 (Big Muskeg Lake). Additional discussion of planned riparian setbacks is provided in the response to Round 1 SIR 146.

Linkages to potential effects on fish habitat, which includes food supply areas, that were determined to be valid for consideration in the Aquatic Ecology Assessment included:

- changes in fish habitat due to direct physical disturbances from the Project facilities and watercourse crossings;
- changes fish habitat productivity due to changes in benthic invertebrate communities assessed based on changes in habitat conditions; and
- changes to fish habitat due to spills and leaks a assessed by the water quality component.

As discussed in Volume 4, Section 4.4.2 all valid linkages between Project activities and potential changes in fish habitat were determined to be negligible.

4.7.4 Decreased Aquatic Biodiversity, As Stronger Species Out-Compete More Sensitive Species

Changes to fish and fish habitat diversity can occur if changes in fish habitat occur in association with the Project that also result in changes in the types of habitats present in the RSA or LSA. Because all valid linkages between Project activities and potential changes in fish habitat identified were classified as negligible (Volume 4, Section 4.4.2), the linkage between changes to fish habitat and changes in fish and fish habitat diversity was broken. As such, no effect is predicted for fish and fish habitat diversity due to changes in fish habitat.

4.7.5 Increased Sport Fishing Activity As Access Is Opened Up

Fishing activities by Whitefish FN are noted to occur at Unnamed Lake 1 (Whitefish FN 2012; Schedule C). This area was previously identified and considered in the Traditional Land Use Assessment (Volume 6, Section 2). Canadian Natural will work with Whitefish FN to better understand the extent and use of this area and to discuss mitigation options to minimize potential effects to traditional fishing, where required.

To mitigate potential increases in fishing pressure, Canadian Natural will prohibit staff and subcontractors from fishing in local lakes while staying at Project camps. Due to implementation of this policy, and based on the assumption that ESRD will provide appropriate management of sustainable fish populations, the Project should result in a negligible change in fishing pressure in the LSA.

4.7.6 Potential for Blocked Fish Passage If Culverts Are Installed Incorrectly

Canadian Natural will design and construct culvert crossings on fish bearing waters to allow fish passage for all fish present or potentially present. To ensure appropriate installation Canadian Natural will follow all regulatory directives and guidelines, including the *Code of Practice for Watercourse Crossings* (AENV 2007) and the *Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta* (Alberta Transportation 2001).

Culverts will be inspected in accordance with Canadian Natural's culvert monitoring and maintenance program and inspection procedures, as outlined in the *Roadway Watercourse Crossing Inspection Manual* (Government of Alberta 2012), will be followed during the inspection of watercourse crossing structures.

4.7.7 Contamination from Spills and/or Leaks

Contamination from spills and/or leaks is addressed above in Section 4.5.1.

4.7.8 Fluctuating Water Levels

Fluctuating water levels are addressed above in Section 4.4.1.

4.8 VEGETATION

Whitefish FN identified the following concerns with regards to vegetation:

- contamination from spills, leaks and dust;
- changes in soil and water conditions affecting vegetation abundance and distribution;
- clearing during construction may result in infiltration of noxious weeds and invasive species, making reclamation difficult;
- impacts on rare plants, culturally important species and other vegetation species of value;
- removal of vegetation impacting traditional gathering activities; and
- creating permanent openings along rights of ways and well pads decreases wildlife habitat and creates space for invasive vegetation to move in.

4.8.1 Contamination from Spills, Leaks and Dust

With the implementation of mitigation measures, as identified in Volume 1, Section 8.4 and Section 4.5.1 above, the effects to vegetation from spills will be minimized.

Potential effects from dust are addressed above in Section 4.1.3.

4.8.2 Changes in Soil and Water Conditions Affecting Vegetation Abundance and Distribution

The Project will involve site clearing and surface disturbance. Site clearing may lead to changes to soil fertility and moisture content, which will have an indirect loss to vegetation communities. Surface disturbance involves the direct removal of the uppermost layers of soil, including associated vegetation and propagules. As described in the Terrain and Soils Assessment (Volume 5, Section 2), the changes to soil quality are negligible and therefore the linkage between changes in soil quality and terrestrial vegetation is broken. As such, no effect is predicted for vegetation abundance and distribution due to changes in soil quality, including soil moisture content.

4.8.3 Clearing during Construction May Result In Infiltration of Noxious Weeds and Invasive Species, Making Reclamation Difficult

Establishment of weeds is most likely to occur as a result of disturbance of soil during construction or dispersal via workers and their vehicles. Equipment will be cleaned before its arrival on site so that it is free of seeds and plant parts. Additional mitigation measures for managing non-native and invasive plants will be implemented throughout construction and operations (Volume 1, Section 11.9.1.1). Canadian Natural will implement a weed management program following the guidelines outlined in the *Weed Management in Forestry Operations Directive 2001-06* (ASRD 2001) and *Weeds on Industrial Development Sites* (AENV 2003b). Canadian Natural will refer to the *Weed Management in Forestry Operations Directive* when considering options for erosion control on soil stockpiles (ASRD 2001a).

During all stages of construction, operations and reclamation, the development areas will be regularly monitored for weed infestations and plant species defined as prohibited noxious or noxious in the *Weed Designation Regulation* A/R19/2010 of *Alberta's Weed Control Act* (GOA 2010b), will be eliminated or controlled. Control techniques will reflect site conditions and the nature of the infestation, and could include a combination of hand pulling, mowing and spot spraying (Volume 1, Section 11.9.1.1).

4.8.4 Impacts on Rare Plants, Culturally Important Species and Other Vegetation Species of Value

There were no rare plant and special plant communities identified in the LSA and RSA, therefore the Project is predicted to have a neutral effect on rare plant and special plant communities. However, this result does not exclude the potential for rare plant communities to exist in the LSA. Rare plant species identified during baseline surveys for the Project are discussed in the response to Round 1 SIR 40. The main effect to rare plants will be due to direct vegetation clearing within the Project footprint. Canadian Natural will implement measures to mitigate effects of vegetation clearing to rare plant species ranked under the Alberta Conservation Information Management System as S1 or S2, as described in Volume 1, Section 11.8.1. Mitigation options will be evaluated on a case-by-case basis as part of the Pre-Disturbance Assessment process and will depend on species population size, adaptability of the species to changes in habitat, and practical ability to translocate the species, as well as construction constraints at a particular site. Mitigation for rare plants during operations will be based on the measures listed in Volume 5, Section 1.6.3.

The Terrestrial Vegetation, Wetlands, and Forestry Assessment assessed the effects of the Project on traditional use plants (high) for the Application Case (Volume 5, Section 3.4.5.1). The assessment determined that, post reclamation, the residual effects of the Project were positive in direction and high in magnitude. The environmental consequence was considered moderate at the LSA scale, and negligible at the RSA scale. Canadian Natural's proposed mitigation to minimize the potential effects of the Project on the traditional land use activities of Aboriginal groups in the region are described in Volume 6, Section 2.5.1

During reclamation planning Canadian Natural will work with Aboriginal Groups to understand plant species that are of importance and that should be considered in reclamation. Many of the tree and shrub planting prescriptions identified in the Conservation and Reclamation Plan (Volume 1, Section 11, Table 11.10-1; Volume 2, Appendix 2-4) include species that are also previously documented traditional use plants (Terrestrial Vegetation, Wetlands and Forestry Baseline, Attachment C, Table C-1).

Information sources Canadian Natural will consider during reclamation include: Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region (AENV 2010), which includes information from the *Fort McKay First Nation, Sagow Pimachiwin: Plants and Animals Used by Mikisew Cree First Nation for Food, Medicine and Material*s (MCFN GIR 2011) and the planting prescriptions in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010), which includes certain traditional use plant species. The reclamation procedures and the planting prescriptions are used to re-establish ecosite phases that support the growth of traditional use plants.

4.8.5 Removal of Vegetation Impacting Traditional Gathering Activities

Whitefish FN has identified two gathering sites in Schedule C of the TLU/TEK Study. These sites do not appear to overlap with the Project footprint. With regards to the gathering site located on the north end of the Project Area, just east of the existing railway, Canadian Natural currently does not have any Project facilities or infrastructure proposed at this general location, and portions of the gathering site appear to be located outside of the Terrestrial LSA. The Terrestrial LSA encompasses the area where there is the highest potential for immediate environmental impacts from the Project to occur. With respect to the gathering site located on the west end of the Resources and Activities map (Schedule C; TEK/TLU Study), this site appears to be outside of both the Project Area and Terrestrial LSA. Given the location of the gathering sites and the Project footprint Canadian Natural does not anticipate the Project will impact the gathering activities at these locations however Canadian Natural will work with Whitefish FN to confirm the extent and use of the gathering sites identified and to discuss additional mitigation options to reduce potential effects to this traditional use, where required.

4.8.6 Creating Permanent Openings along Rights of Ways and Well Pads Decreases Wildlife Habitat and Creates Space for Invasive Vegetation to Move In

For the wildlife assessment Canadian Natural considered the direct effects (site clearing for both facilities and linear corridors) and indirect effects (sensory disturbance, wetlands hydrology and fragmentation) of the Project on wildlife habitat. During construction and operation the environmental consequences for direct and indirect habitat loss are low for western toad, barred owl and beaver, moderate for woodland caribou, and high for Canada lynx, moose, Canada warbler and the old growth forest bird community at the LSA scale, and negligible for all KIRs at the RSA scale.

Mitigation proposed by Canadian Natural to reduce Project effects on wildlife are discussed in Volume 5, Section 1.6, and include, among other measures, commitments regarding timing restrictions on clearing, the use of wildlife crossing structures and under the pipe crossing opportunities on above-ground-pipelines. Canadian Natural will also endeavour to use common corridors and shared access with other resource users in the proposed Project Area to reduce the amount of new vegetation clearing and ground disturbance. In addition, plant communities targeted during reclamation will be designed to be compatible with on-site ecological conditions and to provide habitat for wildlife Key Indicator Resources (KIR).

Reclamation of vegetation communities results in increases in high-suitability habitat for Canada warbler, Canada lynx and barred owl. This results in associated negligible to high positive environmental consequences. Following reclamation the environmental consequences of habitat loss for all other wildlife KIRs are expected to be negligible to low (Volume 5, Section 4.4.2.2).

Invasive species are discussed above in Section 4.8.3.

4.9 WILDLIFE

Whitefish FN have identified the following concerns with regards to wildlife:

- habitat loss, disturbance, alteration and fragmentation due to noise, blocked areas, clearing, and permanent landscape changes and avoidance by wildlife;
- impacts to feeding, nesting, denning or breeding patterns;
- physical barriers to movement and migration;
- increased hunting and predation;
- increased mortality due to human/wildlife interactions;
- pollution of habitats, food and water sources;
- increased threats to Species at Risk and culturally important species; and
- impacts to traditional hunting and trapping activities.

4.9.1 Habitat Loss, Disturbance, Alteration and Fragmentation Due To Noise, Blocked Areas, Clearing, and Permanent Landscape Changes and Avoidance by Wildlife

The effects of the Project on wildlife habitat, which included effects from site clearing (both from facilities and linear corridors), sensory disturbance (e.g., noise) and fragmentation are discussed in Section 4.8.6.

4.9.2 Impacts to Feeding, Nesting, Denning or Breeding Patterns

The effects of the Project on wildlife habitat which considers feeding, nesting and denning or breeding patterns are discussed in Section 4.8.6.

4.9.3 Physical Barriers to Movement and Migration

As indentified in Volume 5, Section 4.4.2.3 development can impede the movement of wildlife on a local and regional scale. Large disturbances (e.g., major infrastructure) as well as linear disturbances (e.g., roads and above-ground pipelines) can act as barriers to movement and migration.

The Project effects on wildlife movement as a result of large and linear disturbances during construction and operation were assessed in the Wildlife Assessment (Volume 5, Section 4.4.2.3) and were predicted to be negligible to low for all wildlife KIRs within the LSA and RSA except for caribou which was moderate for both the LSA and RSA. Post reclamation, the effects to wildlife movement were determined to be negligible for all wildlife, including caribou.

Mitigation proposed by Canadian Natural to reduce Project effects on movement of wildlife during the design, construction, operations and reclamation stages of the Project are discussed in Volume 5, Section 1.6 and the response to Round 1 SIRs 205 and 254 (Canadian Natural 2012). The mitigation may include, among other measures, the use of wildlife crossing structures, under the pipe crossing opportunities on above-ground-pipelines, habitat restoration and reclamation. The removal of the barriers to wildlife movement in the LSA after reclamation will result in the re-establishment of wildlife habitat, increasing wildlife habitat connectivity across the LSA and RSA.

Canadian Natural will establish a wildlife monitoring plan to measure the effectiveness of mitigation, restoration of wildlife habitat, and the distribution and abundance of wildlife at the local scale, including federally and provincially-listed species. Canadian Natural will consult with ESRD during the development of the Project on the wildlife monitoring program. Wildlife monitoring information collected by Canadian Natural will be provided to ESRD to support regional wildlife management efforts. Additional details on the wildlife monitoring plan are provided in Volume 5, Section 4.6.

4.9.4 Increased Hunting and Predation

Hunting and trapping activities by Whitefish FN are noted to occur at several areas within the Project Area (Whitefish FN 2012; Schedule C Constraints Map). In some cases, the locations of these activities overlap with the Project footprint. Canadian Natural recognizes that hunting is an activity that can occur over large areas and will work with Whitefish FN to better understand the extent of the hunting areas and to discuss mitigation options to minimize potential effects to this traditional use, where required.

As Project development results in new clearings, access to the land for some resource uses, such as hunting, may improve during the life of the Project. Canadian Natural acknowledges that increased access may result in increased activity and recreational uses of non-native hunters, however the Resource Use Assessment indicates that non-Aboriginal use of the access in the LSA is likely low due its distance from larger centres within and outside the Resource Use RSA (Volume 6, Section 3.6.1.3).

Proposed mitigation measures to address potential impacts from increased access include:

- Shared access will be used wherever possible. New clearings will be minimized by sharing space with utility corridors where possible.
- Careful consideration will be given to alternate routes before re-opening existing lines that are starting to regenerate.

With the implementation of these mitigation measures the potential effects relating to access will be reduced. The implementation of mitigation measures results in a negligible environmental consequence for beaver, Canada Lynx and woodland caribou at both the LSA and RSA scales (Volume 5, Section 4.4.2.1).

To protect wildlife from changes in access, Canadian Natural may use roll backs along ROW no longer used for the Project as a means to control access at various times. A roll back is an access control method used on winter access roads, pipelines, seismic lines where cut timber is rolled back or placed on the opened access to prevent motorized vehicle travel. Usually the timber is spread back at the start of the road for approximately 100 to 150 m.

4.9.5 Increased Mortality Due To Human/Wildlife Interactions

The EIA considered the effects of the Project on vehicle-wildlife collisions as a result of increased traffic. The environmental consequence for wildlife-vehicle collisions is predicted to be negligible for western toads at the both the LSA and RSA scales and low for all other KIRs (e.g., moose, woodland caribou and beaver) at the LSA and RSA Scales (Volume 5, Section 4.4.2).

As described in Volume 5, Section 4.6 monitoring and subsequent mitigation that will be implemented on roads to minimize effects to wildlife include:

- monitoring of roads to identify areas where wildlife are active and where adjustment to the speed limit and/or posting of warnings may be warranted;
- monitoring of snow berms along roads to ensure that where recurring tracks are observed the berms are not too high (i.e., greater than 1 m) and allow wildlife movement across the roads; and

- monitoring for wildlife road kill and keeping mortality logs to check for trends that may require mitigation.

4.9.6 Pollution of Habitats, Food and Water Sources

Pollution of habitats, food and water sources from air emissions are addressed above in Section 4.1, and leaks and spills are addressed above in Section 4.5.1 and 4.8.1.

4.9.7 Increased Threats to Species at Risk and Culturally Important Species

The Wildlife Assessment (Volume 5, Section 4.4), assessed the effects of the Project on wildlife abundance. Species of concern and culturally important species that were chosen as Key Indicator Resources (KIRs) and used in the assessment include beaver, Canada lynx, moose, woodland caribou, Canada warbler, rusty blackbird, yellow rail, western toad, among others. The assessment considered effects due to the following:

- site clearing;
- removal of nuisance wildlife;
- interactions of wildlife with infrastructure;
- increase in predation/hunting/trapping;
- increased vehicle-wildlife collisions; and
- sensory disturbance.

The residual effects of the Project on wildlife abundance (beaver, Canada lynx, moose and woodland caribou) under the Application Case (Construction and Operations) were determined to be low at the local scale and negligible at the regional scale (Volume 5, Section 4.4.2.1, Table 4.4-1).

Mitigation proposed by Canadian Natural to reduce Project effects on wildlife are discussed in Volume 5, Section 1.6, and include, among other measures, commitments regarding timing restrictions on clearing, the use of wildlife crossing structures and under the pipe crossing opportunities on above-ground-pipelines. Canadian Natural will also endeavour to use common corridors and shared access with other resource users in the proposed Project Area to reduce the amount of new vegetation clearing and ground disturbance. In addition, plant communities targeted during reclamation will be designed to be compatible with on-site ecological conditions and to provide habitat for wildlife Key Indicator Resources (KIR).

In consideration of the results for wildlife abundance, habitat (Section 4.8.6 above) and movement (Section 4.9.3 above), the overall environmental consequences during construction and operation of the Project and prior to reclamation, for species at risk or culturally important species are predicted to range from low for western toad and beaver to moderate for woodland caribou and high for moose, Canada warbler, rusty blackbird, yellow rail at the LSA scale, and negligible for all these species at the RSA scale. The overall effects of the Project on species at risk or culturally important species after reclamation will be low for rusty blackbird and yellow rail, and negligible for all others at the LSA scale, and negligible for all species at risk or culturally important species at the RSA scale (Volume 5, Section 4.7.3.2).

4.9.8 Impacts to Traditional Hunting and Trapping Activities

Hunting and trapping activities by Whitefish FN are noted to overlap with the Project Area (Whitefish FN 2012; Schedule C Resources and Activities Map). Canadian Natural recognizes that hunting is an activity that can occur over large areas and will work with Whitefish FN to better understand the extent and use of the hunting areas identified and to discuss mitigation options to minimize potential effects to traditional fishing, where required

4.10 ACCIDENTS AND MALFUNCTIONS

Whitefish FN members note that facility and pipeline failures are not uncommon and have lasting impacts – on small and large scales – on human communities, water, fish, vegetation, wildlife, air and soil.

Prompt and effective response to emergency situations is a guiding principle of Canadian Natural's Corporate Statement on Health & Safety. Canadian Natural has a number of emergency response plans including the well-developed, implemented and tested Corporate Emergency Response Plan (ERP). Canadian Natural's Corporate ERP is continually updated to comply with changes to Energy Resources Conservation Board (ERCB) Directive 071: Emergency Preparedness and Response Requirements for the Upstream Petroleum Industry (Directive 071) (EUB 2003b). The Corporate ERP will be applicable to the Kirby Expansion Project (Volume 1, Section 8.4). Canadian Natural believes that use of the ERP as well as effective response to emergency situations will reduce potential impact of accidents or malfunctions on human communities, water, fish, vegetation, wildlife, air and soil.

4.11 CUMULATIVE EFFECTS

As described in Volume 3, Section 1.4.1.4, the assessments and resulting environmental consequence ratings that are provided in the EIA take into account three assessment scenarios: the Baseline Case, the Application Case and the PDC. Both the Application Case and the PDC allow conclusions to be drawn about the potential effects of the Project in combination with other industrial developments in the region. The Application Case addresses the potential effects of the Project in combination with the potential effects of both existing and approved activities while the PDC addresses the potential effects of the Project in combination with the potential effects of existing, approved and planned activities. As part of the EIA Canadian Natural considered the potential impacts to health, air quality, water quantity and quality (groundwater and surface water) and land disturbance in the LSA and RSA for both the Application and PDC, as appropriate.

4.12 SOCIO-CULTURAL AND ECONOMIC EFFECTS

Whitefish FN has also identified socio-cultural and economic effects. The Project specific concerns identified are addressed in the Socio-Economic Assessment (Volume 6, Section 5). Some of the concerns identified may not be addressed in the EIA as they may be more appropriately addressed by federal and/or provincial governments or regional planning/initiatives.

5 TLU ASSESSMENT UPDATE

As described in Volume 6, Section 2.5.4.2, a review of previous TLU studies, TLU assessments for other projects, and other regional reports suggested that areas overlapping the LSA have been traditionally used by Aboriginal groups. The TLU/TEK studies provided by HLFN and Whitefish FN have identified traditional land use areas not previously considered in the Traditional Land Use Assessment, that may overlap with the Project footprint:

- two Cabins; one located to the south of Rat Lake and one located north east of Wiau Lake (HLFN); and
- approximately eight hunting and trapping areas (Whitefish Lake FN).

The remaining traditional land use areas identified in the HLFN and Whitefish FN TEK/TLU Studies were already incorporated and considered in the traditional land use assessment completed for the EIA.

Canadian Natural will work with the communities to ground truth the traditional land use areas identified to better understand the extent and use of these lands for traditional activities and to discuss mitigation options, where necessary.

With the application of mitigation measures, the Project is not predicted to affect the identified traditional uses in the LSA. Therefore, the information provided in the HLFN and Whitefish FN TLU studies do not change the assessment predictions in the EIA regarding effects to traditional hunting, trapping, fishing, traditional plant gathering and cultural sites.

6 REFERENCES

AENV (Alberta Environment). 2003a. *Groundwater Evaluation Guideline.* Edmonton, AB. 46 p. Available online. http://environment.gov.ab.ca/info/library/7508.pdf

AENV. 2003b. *Weeds on Industrial Development Sites*. Regulations and Guidelines. R&R/03-4, September 2003.

AENV. 2006. *Water Conservation and Allocation Guideline for Oilfield Injection.* Edmonton, AB. 64pp. Available online. http://environment.gov.ab.ca/info/library/7700.pdf

AENV. 2008. *Guideline for Wetland* Establishment *on Reclaimed Oil Sands Leases (2nd Edition)*. Prepared by Harris, M.L. of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. December 2007. Edmonton, AB. 330 pp. ISBN: 978-0-7785-7697-6.

AENV. 2011. *Alberta Environment Guide to Groundwater Authorization.* Edmonton, AB. 36pp. Available online. http://environment.gov.ab.ca/info/library/8361.pdf

ASRD (Alberta Sustainable Resource Development). 2009. *Alberta's Strategy for the Management of Species at Risk (2009-2014).* Alberta Sustainable Resource Development, Fish and Wildlife Division. Publication No.: I/323. Edmonton, Alberta. 30 pp. ISBN: 978-0-778-7717-1 (Printed Edition); 978-0-7785-7718-8 (On-line Edition).

ASRD. 2001. Weed Management in Forestry Operations Directive 2001-06.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Submitted to Energy Resources Conservation Board and Alberta Environment and Water. December 2011.

Canadian Natural. 2012. *Application for Approval of the Kirby In Situ Oil Sands Expansion Project*. Supplemental Information Submitted to Energy Resources Conservation Board and Alberta Environment and Sustainable Resource Development. August 2012.

Cenovus. 2010. *Application for Approval of the Cenovus Narrows Lake Project. Integrated Application and Environmental Impact Assessment*. Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment. June 2010. Calgary, AB.

DFO (Department of Fisheries and Oceans Canada). 1995. *Freshwater Intake End-of-Pipe Fish Screen Guidelines.* Communication Directorate, Department of Fisheries and Oceans. Ottawa, ON.

Environment Canada. 2012. *Recovery Strategy for the Woodland Caribou (Rangifer tarandus caribou), Boreal population, in Canada*. Ottawa, ON. 138 pp.

EUB (Energy and Utilities Board). 1994. *Directive 051: Injection and Disposal Wells - Well Classifications, Completions, Logging, and Testing Requirements*. March 1994.

Everett, K.R. 1980. *Distribution and Properties of Road Dust Along the Northern Portion of the Haul Road.* In J. Brown and R. L. Berg (ed.). Environmental Engineering and Ecological Baseline Investigations Along the Yukon River-Prudhoe Bay Haul Road. Cold Regions Research and Engineering Laboratory. p. 101-128.

Government of Alberta. 2011a. *2011 Alberta Guide to Hunting Regulations*. Edmonton, AB.

Government of Alberta. 2011b. *A Woodland Caribou Policy for Alberta*. Available online. http://www.srd.alberta.ca/FishWildlife/WildlifeManagement/CaribouManagement/documents/WoodlandCaribouPolicy-Alberta-Jun2011.pdf

HLFN (Heart Lake First Nation Consultation Office). 2012. Draft *HLFN TLU/TEK Information as it relates to: Canadian Natural Resources Limited re: Kirby In Situ Oil Sands Project*. July 19, 2012. 34 pp.

Suncor. 2010. *Suncor MacKay River 2010 ERCB Performance Presentation – Commercial Scheme Approval No. 8668*. Presentation on October 21, 2010. Available online. http://www.ercb.ca/docs/products/osprogressreports/2010/2010AthabascaSuncorMackayRiverSAGD8668_Surface.pdf

Walker, D.A. and K.R. Everett. 1987. *Road Dust and its Environmental Impact on Alaskan Taiga and Tundra.* Arctic and Alpine Research. 19. p. 479-489.

Whitefish Lake First Nation #128 (Whitefish FN). 2012. *Traditional Use Assessment Report. Submitted to Canadian Natural Resources Limited*. June 28, 2012. 47 pp.

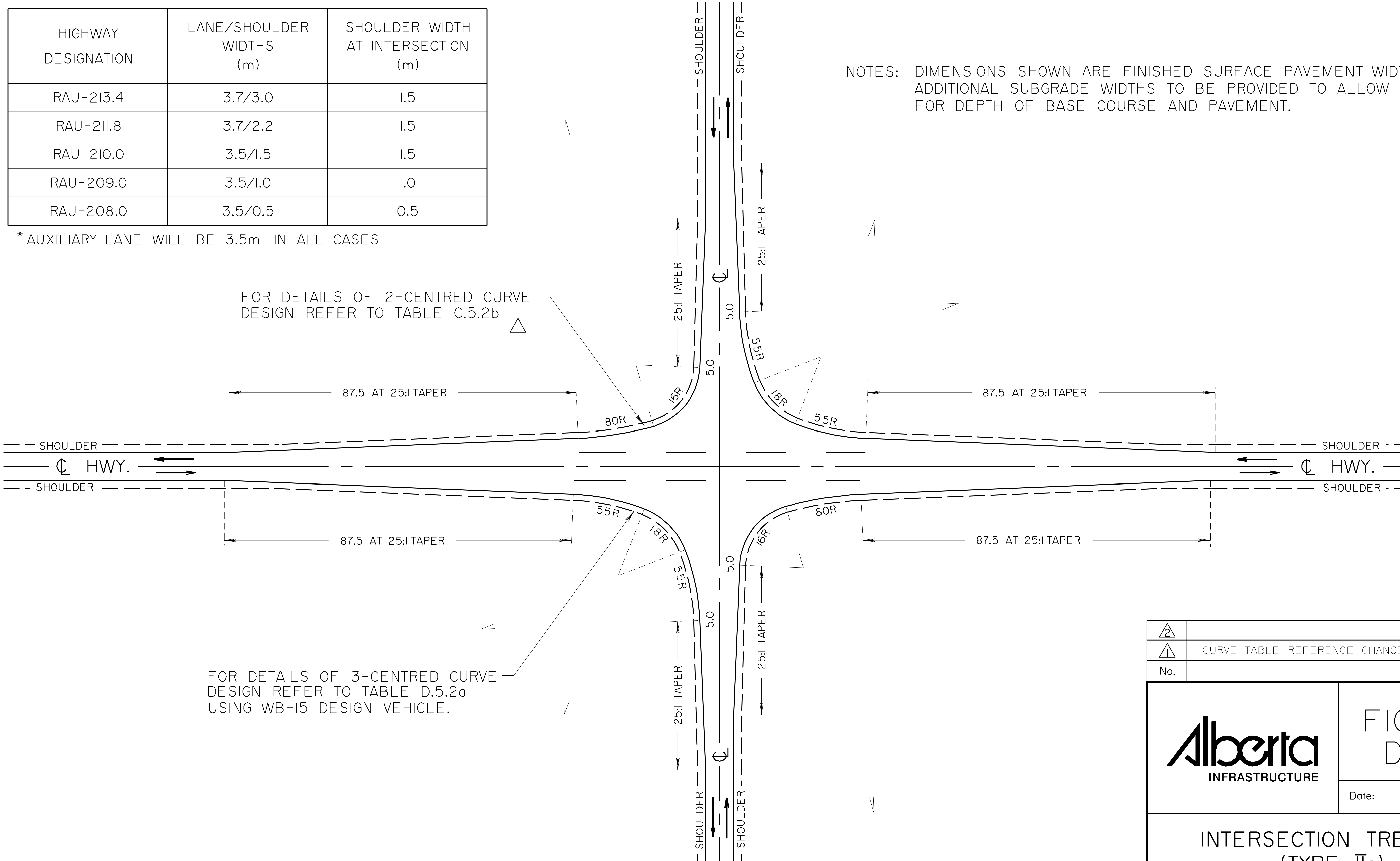
APPENDIX 5-1

SUPPORTING TRANSPORTATION INFORMATION

HIGHWAY DESIGNATION	LANE/SHOULDER WIDTHS (m)	SHOULDER WIDTH AT INTERSECTION (m)
RAU-213.4	3.7/3.0	1.5
RAU-211.8	3.7/2.2	1.5
RAU-210.0	3.5/1.5	1.5
RAU-209.0	3.5/1.0	1.0
RAU-208.0	3.5/0.5	0.5

* AUXILIARY LANE WILL BE 3.5m IN ALL CASES

NOTES: DIMENSIONS SHOWN ARE FINISHED SURFACE PAVEMENT WIDTHS. ADDITIONAL SUBGRADE WIDTHS TO BE PROVIDED TO ALLOW FOR DEPTH OF BASE COURSE AND PAVEMENT.



No.		BY	DATE
2			
1	CURVE TABLE REFERENCE CHANGED	R.M.	05/96

Alberta INFRASTRUCTURE

FIGURE D-7e

Date: APRIL 1995

INTERSECTION TREATMENT (TYPE IIc) (TWO-LANE HIGHWAY)

Prepared By: Cgk | Checked By: B.K. | Scale: N.T.S.

Graphics File: debd7e.man

Table D.5.2a Edge of Lane Design for Right Turn at Intersection and Data for Three-Centred Curves

(Refer to Figure D-5.2a)

Design Vehicle	Angle of Turn (degrees)	Simple Curve Radius (metres)	Three-Centred Compound Curve Symmetric		Three-Centred Compound Curve Asymmetric	
			Radii $R_1 - R_2 - R_1$ (metres)	Offset P (metres)	Radii $R_1 - R_2 - R_3$ (metres)	Offset P Min. - Max. (metres)
P	30	18	-	-	-	-
SU-9		30	-	-	-	-
WB-12		46	-	-	-	-
WB-15		61	-	-	-	-
P	45	15	-	-	-	-
SU-9		23	-	-	-	-
WB-12		37	-	-	-	-
WB-15		52	61 - 30 - 61	1	-	-
P	60	12	-	-	-	-
SU-9		18	-	-	-	-
WB-12		27	-	-	-	-
WB-15		-	61 - 23 - 61	1.5	61 - 23 - 84	0.5 - 2.0
P	75	11	30 - 8 - 30	0.5	-	-
SU-9		17	37 - 14 - 37	0.5	-	-
WB-12		26	37 - 14 - 37	1.5	37 - 14 - 61	0.5 - 2.0
WB-15		-	46 - 15 - 46	2.0	46 - 15 - 69	0.5 - 3.0
P	90	9	30 - 16 - 30	1.0	-	-
SU-9		15	37 - 12 - 37	0.5	-	-
WB-12		-	37 - 12 - 37	1.5	37 - 12 - 61	0.5 - 2.0
WB-15		-	55 - 18 - 55	2.0	37 - 12 - 61	0.5 - 3.0
P	105	-	30 - 6 - 30	1.0	-	-
SU-9		-	30 - 11 - 30	1.0	-	-
WB-12		-	30 - 11 - 30	1.5	30 - 11 - 61	0.5 - 2.5
WB-15		-	55 - 14 - 55	2.5	46 - 12 - 64	0.5 - 3.0
P	120	-	30 - 6 - 30	0.5	-	-
SU-9		-	30 - 9 - 30	1.0	-	-
WB-12		-	37 - 9 - 37	2.0	30 - 9 -55	0.5 - 3.0
WB-15		-	55 - 12 - 55	2.5	46 - 11 - 67	0.5 - 3.5
P	135	-	30 - 6 - 30	0.5	-	-
SU-9		-	30 - 9 - 30	1.0	-	-
WB-12		-	37 - 9 - 37	2.0	30 - 8 - 55	1.0 - 4.0
WB-15		-	49 - 11 - 49	3.0	40 - 9 - 56	1.0 - 4.0
P	150	-	23 - 5 - 23	0.5	-	-
SU-9		-	30 - 9 - 30	1.0	-	-
WB-12		-	30 - 9 - 30	2.0	26 - 8 - 49	1.0 - 3.0
WB-15		-	49 - 11 - 49	2.0	37 - 9 - 55	1.0 - 4.0
P	180	-	15 - 5 - 15	0.1	-	-
SU-9		-	30 - 9 - 30	0.5	-	-
WB-12		-	30 - 6 - 30	3.0	26 - 6 - 46	2.0 - 4.0
WB-15		-	40 - 8 - 40	3.0	30 - 8 - 55	2.0 - 4.0

Note: The edge of lane design shown here for the WB-15 design vehicle will accommodate the wheel path of large semi-trailer units (WB-21) on the medium turning template without any wheels encroaching on the shoulder. The WB-23 (Super B-train) and all of the smaller design vehicles are also accommodated. The use of the "medium" turning radius plus the additional width of the shoulder provide a suitable margin of safety to reduce the occurrence of rear wheels tracking off the pavement surface.

Table D.5.2b Edge of Lane Design for Right Turn at Intersection and Data for Two-Centred Curves [Stop condition from intersecting road tomain (or through) highway on tangent alignment]

(Refer to Figure D-5.2b)

Δ (deg)	Δ_2 (deg min)	R_2 (m)	T_2 (m)	L_2 (m)	Δ_1 (deg min)	R_1 (m)	T_1 (m)	L_1 (m)	a (m)	b (m)
70°	53°30'	18	9.073	16.808	16°30'	80	11.599	23.038	29.283	15.321
71°	54°35'	18	9.287	17.148	16°25'	80	11.540	22.922	29.491	15.513
72°	55°40'	18	9.504	17.488	16°20'	80	11.481	22.806	29.701	15.709
73°	56°45'	18	9.722	17.829	16°15'	80	11.421	22.689	29.911	15.909
74°	57°50'	18	9.943	18.169	16°10'	80	11.362	22.573	30.124	16.115
75°	58°55'	17	9.602	17.481	16°05'	80	11.303	22.457	29.837	15.597
76°	60°00'	17	9.815	17.802	16°00'	80	11.243	22.340	30.039	15.797
77°	61°00'	17	10.014	18.099	16°00'	80	11.243	22.340	30.324	16.027
78°	62°00'	17	10.215	18.396	16°00'	80	11.243	22.340	30.613	16.261
79°	63°00'	17	10.418	18.692	16°00'	80	11.243	22.340	30.904	16.500
80°	64°00'	17	10.623	18.989	16°00'	80	11.243	22.340	31.200	16.743
81°	65°00'	17	10.830	19.286	16°00'	80	11.243	22.340	31.498	16.990
82°	66°00'	17	11.040	19.583	16°00'	80	11.243	22.340	31.800	17.242
83°	67°00'	17	11.252	19.879	16°00'	80	11.243	22.340	32.106	17.499
84°	68°00'	17	11.467	20.176	16°00'	80	11.243	22.340	32.416	17.761
85°	69°00'	16	10.996	19.268	16°00'	80	11.243	22.340	32.085	17.150
86°	70°00'	16	11.203	19.548	16°00'	80	11.243	22.340	32.388	17.406
87°	71°00'	16	11.413	19.827	16°00'	80	11.243	22.340	32.694	17.666
88°	72°00'	16	11.625	20.106	16°00'	80	11.243	22.340	33.005	17.932
89°	73°00'	16	11.839	20.385	16°00'	80	11.243	22.340	33.321	18.203
90°	74°00'	16	12.057	20.665	16°00'	80	11.243	22.340	33.641	18.479
91°	75°00'	16	12.277	20.944	16°00'	80	11.243	22.340	33.966	18.761
92°	76°00'	15	11.719	19.897	16°00'	80	11.243	22.340	33.537	18.052
93°	77°00'	15	11.932	20.159	16°00'	80	11.243	22.340	34.855	18.328
94°	78°00'	15	12.147	20.420	16°00'	80	11.243	22.340	34.178	18.610
95°	79°00'	15	12.365	20.682	16°00'	80	11.243	22.340	34.506	18.897
96°	80°00'	15	12.586	20.944	16°00'	80	11.243	22.340	34.840	19.191
97°	81°00'	15	12.811	21.206	16°00'	80	11.243	22.340	35.180	19.491
98°	82°00'	15	13.039	21.468	16°00'	80	11.243	22.340	35.526	19.798
99°	83°00'	15	13.271	21.729	16°00'	80	11.243	22.340	35.878	20.111
100°	84°00'	14	12.606	20.525	16°00'	90	12.649	25.133	38.152	19.674
101°	85°00'	14	12.829	20.769	16°00'	90	12.649	25.133	38.504	19.983
102°	86°00'	14	13.055	21.014	16°00'	90	12.649	25.133	38.863	20.298
103°	87°00'	14	13.286	21.258	16°00'	90	12.649	25.133	39.229	20.622
104°	88°00'	14	13.520	21.502	16°00'	90	12.649	25.133	39.602	20.953
105°	89°10'	14	13.798	21.788	15°50'	90	12.515	24.871	39.754	21.230
106°	90°20'	14	14.082	22.073	15°40'	90	12.382	24.609	39.911	21.516
107°	91°30'	14	14.371	22.358	15°30'	90	12.248	24.347	40.075	21.810
108°	92°40'	14	14.667	22.643	15°20'	90	12.115	24.086	40.245	22.114
109°	93°50'	14	14.969	22.928	15°10'	90	11.982	23.824	40.422	22.427
110°	95°00'	14	15.278	23.213	15°00'	90	11.849	23.562	40.607	22.750

Note: In cases where the angle (Δ) is not an exact even number of degrees, the designers should round off to the nearest degree, then use the exact numbers as shown on the table for R_1, R_2 and Δ_2. The difference (either more or less) can be made up by varying the value of Δ_1.

Note: The edge of lane design shown here will accommodate the wheel path of large semi-trailer units (WB-21) on the medium turning template without any wheels encroaching on the shoulder. The WB-23 (Super B-train) and all of the smaller design vehicles are also accommodated. The use of the "medium" turning radius plus the additional width of the shoulder provide a suitable margin of safety to reduce the occurrence of rear wheels tracking off the pavement surface.

Warrants for Intersection Lighting (See Note 2)

From: Transportation Association of Canada (TAC) "Illumination of Isolated Rural Intersections" (Feb. 2001)

Road Name	Highway 881:21		
From	km 18	to	km 19
City	RMWB		
Warrant Undertaken By	Glen Holland		
Company Name	AECOM		
Date	1-Nov-12		

2015 PLANNING HORIZON VOLUMES - KIRBY SITE ACCESS

Item No	Classification Factor	Rating Factor (R) 0	1	2	3	4	Weight Subcategory (if applicable)	Weight (W)	Enter 'R' Here	Score: 'R' x 'W'
	Geometric Factors (G)									
1	Channelization	None	Right and/or Left Turn Lanes on Minor Approach Only	Right Turn Lane(s) Only on Major Leg(s)	Left Turn Lane(s) on Major Leg(s)	Left and Right Turn Lanes on All Legs	Raised and Operating Speed Less Than 70km/h on at Least One Channelized Approach or	15	0	0
							Raised and Operating Speed Less Than 70km/h or More on at Least One Channelized Approach or	20	0	0
							Painted Only	5	2	10
2	Approach Sight Distance on the Most Constrained Approach (Relative to Recommended Minimum Intersection Sight Distance)	100% or More	75% to 99%	50% to 74%	25% to 49%	< 25%		10	0	0
3	Horizontal Curvature (Radius) at or Immediately Before Intersection on Any Leg for Posted Speed Limit of:									
	110 km/h:	Tangent	> 1800 m	1150 to 1800 m	750 to 1150 m	< 750 m		5	0	0
	90 or 100 km/h:	Tangent	> 1400 m	950 to 1400 m	600 to 950 m	< 600 m				
	70 or 80 km/h:	Tangent	> 950 m	550 to 950 m	340 to 550 m	< 340 m				
	60 km/h:	Tangent	>575 m	320 to 575 m	190 to 320 m	< 190 m				
4	Angle of Intersection or Offset Intersection	90 Degree Angle	80 or 100 Degree Angle	-	70 or 100 Degree Angle	< 70 or >100 Degree or Offset Intersection		5	1	5
5	Downhill Approach Grades at or Immediately Before Intersection on Any Leg	< 3.0 %	3.1 to 3.9% and Meets Design Guidelines for Type and Speed of Road	4.0 to 4.9% and Meets Design Guidelines for Type and Speed of Road	5.0 to 7.0% and Meets Design Guidelines for Type and Speed of Road	> 7.0% OR Exceeds Maximum Gradient for Type and Speed of Road		3	0	0
6	Number of Legs	-	3	4	5	6 or More		3	2	6
								Subtotal Geometric Factors		**21**
	Operational Factors (O)									
If the intersection is signalized, illumination is warranted. If the intersection is NOT signalized, Points should be calculated on the Basis of EITHER the AADT Factor of the Signalization Warrant Factor										
7	Either AADT (2-way) (See Note 1)									
	On Major Road and	< 1000	1000 to 2000	2000 to 3000	3000 to 5000	> 5000		10	2	20
	On Minor Road OR	<500	500 to 1000	1000 to 1500	1500 to 2000	> 2000		20	1	20
	Signalization Warrant (See Note 1)	Intersection Not Signalized and Volume-Based Signal Warrant is Less than 20% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 20% to 40% Satisfied	Intersection Not Signalized and Volume-Based Warrant is 40% to 60% Satisfied	Intersection Not Signalized and Volume-Based Warrant is 60% to 80% Satisfied	Intersection Not Signalized and Volume-Based Warrant is Over 80% Satisfied		30	0	0
8	Regular Nighttime Hourly Pedestrian Volume (See Note 2)	No Pedestrians	Up to 10	10 to 30	30 to 50	Over 50		10	0	0
9	Intersecting Roadway Classifications	No Primary Road Involved	Primary/Rural Major, Primary/Rural Minor OR Primary/Designated Community Access	Primary/ Secondary	Primary/ Primary	Intersection Includes Divided Highway		5	1	5
10	Operating Speed or Posted Speed Limit on Major Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	4	20
11	Operating Speed or Posted Speed Limit on Minor Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	91 km/h or Over		5	0	0
								Subtotal Operational Factors		**65**
	Environmental Factors (E)									
12	Lighted Development Within 150 m Radius of Intersection	-	In One Quadrant	In Two Quadrants	In Three Quadrants	In Four Quadrants	5.00	5	0	0
								Subtotal Environmental Factors		**0**
	Collision Factors (A)									
13	Average Annual Nighttime Collision Frequency (See Note 4) or Rate Over Last Three Years (Only Collisions Potentially Attributable to Inadequate Lighting)	0 Collisions per Year	1 Collision per Year	-	3 or More Collisions per Year OR At Least 1.5 Collisions per Million Entering Vehicles per Year and an Average Ratio of All Night-to-Day Collisions of At Least 1.5		1 or 2 Collisions per Year	15	1	15
							3 or More Collisions per Year or Rate >= 1.5 Collisions/MEV	30	0	
								Subtotal Collision Factors		**15**
								G + O + E + A = Total Warranting Points		**101**
								Warranting Condition		**120**
								Difference +/-		**-19**

Warrants for Intersection Lighting (See Note 2)

From: Transportation Association of Canada (TAC) "Illumination of Isolated Rural Intersections" (Feb. 2001)

Road Name	Highway 881:21		
From	km 18	to	km 19
City	RMWB		
Warrant Undertaken By	Glen Holland		
Company Name	AECOM		
Date	1-Nov-12		

2035 PLANNING HORIZON VOLUMES - KIRBY SITE ACCESS

Item No	Classification Factor	Rating Factor (R) 0	1	2	3	4	Weight Subcategory (if applicable)	Weight (W)	Enter 'R' Here	Score: 'R' x 'W'
	Geometric Factors (G)									
1	Channelization	None	Right and/or Left Turn Lanes on Minor Approach Only	Right Turn Lane(s) Only on Major Leg(s)	Left Turn Lane(s) on Major Leg(s)	Left and Right Turn Lanes on All Legs	Raised and Operating Speed Less Than 70km/h on at Least One Channelized Approach or	15	0	0
							Raised and Operating Speed Less Than 70km/h or More on at Least One Channelized Approach or	20	0	0
							Painted Only	5	2	10
2	Approach Sight Distance on the Most Constrained Approach (Relative to Recommended Minimum Intersection Sight Distance)	100% or More	75% to 99%	50% to 74%	25% to 49%	< 25%		10	0	0
3	Horizontal Curvature (Radius) at or Immediately Before Intersection on Any Leg for Posted Speed Limit of:									
	110 km/h:	Tangent	> 1800 m	1150 to 1800 m	750 to 1150 m	< 750 m		5	0	0
	90 or 100 km/h:	Tangent	> 1400 m	950 to 1400 m	600 to 950 m	< 600 m				
	70 or 80 km/h:	Tangent	> 950 m	550 to 950 m	340 to 550 m	< 340 m				
	60 km/h:	Tangent	>575 m	320 to 575 m	190 to 320 m	< 190 m				
4	Angle of Intersection or Offset Intersection	90 Degree Angle	80 or 100 Degree Angle	-	70 or 100 Degree Angle	< 70 or >100 Degree or Offset Intersection		5	1	5
5	Downhill Approach Grades at or Immediately Before Intersection on Any Leg	< 3.0 %	3.1 to 3.9% and Meets Design Guidelines for Type and Speed of Road	4.0 to 4.9% and Meets Design Guidelines for Type and Speed of Road	5.0 to 7.0% and Meets Design Guidelines for Type and Speed of Road	> 7.0% OR Exceeds Maximum Gradient for Type and Speed of Road		3	0	0
6	Number of Legs	-	3	4	5	6 or More		3	2	6
								Subtotal Geometric Factors		**21**
	Operational Factors (O)									
	If the intersection is signalized, illumination is warranted. If the intersection is NOT signalized, Points should be calculated on the Basis of EITHER the AADT Factor of the Signalization Warrant Factor									
7	Either AADT (2-way) (See Note 1)									
	On Major Road and	< 1000	1000 to 2000	2000 to 3000	3000 to 5000	> 5000		10	3	30
	On Minor Road OR	<500	500 to 1000	1000 to 1500	1500 to 2000	> 2000		20	1	20
	Signalization Warrant (See Note 1)	Intersection Not Signalized and Volume-Based Signal Warrant is Less than 20% Satisfied	Intersection Not Signalized and Volume-Based Signal Warrant is 20% to 40% Satisfied	Intersection Not Signalized and Volume-Based Warrant is 40% to 60% Satisfied	Intersection Not Signalized and Volume-Based Warrant is 60% to 80% Satisfied	Intersection Not Signalized and Volume-Based Warrant is Over 80% Satisfied		30	0	0
8	Regular Nighttime Hourly Pedestrian Volume (See Note 2)	No Pedestrians	Up to 10	10 to 30	30 to 50	Over 50		10	0	0
9	Intersecting Roadway Classifications	No Primary Road Involved	Primary/Rural Major, Primary/Rural Minor OR Primary/Designated Community Access	Primary/ Secondary	Primary/ Primary	Intersection Includes Divided Highway		5	1	5
10	Operating Speed or Posted Speed Limit on Major Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	90 km/h or Over		5	4	20
11	Operating Speed or Posted Speed Limit on Minor Road (See Note 3)	50 km/h or Less	60 km/h	70 km/h	80 km/h	91 km/h or Over		5	0	0
								Subtotal Operational Factors		**75**
	Environmental Factors (E)									
12	Lighted Development Within 150 m Radius of Intersection	-	In One Quadrant	In Two Quadrants	In Three Quadrants	In Four Quadrants	5.00	5	0	0
								Subtotal Environmental Factors		**0**
	Collision Factors (A)									
13	Average Annual Nighttime Collision Frequency (See Note 4) or Rate Over Last Three Years (Only Collisions Potentially Attributable to Inadequate Lighting)	0 Collisions per Year	1 Collision per Year	-	3 or More Collisions per Year OR At Least 1.5 Collisions per Million Entering Vehicles per Year and an Average Ratio of All Night-to-Day Collisions of At Least 1.5		1 or 2 Collisions per Year	15	1	15
							3 or More Collisions per Year or Rate >= 1.5 Collisions/MEV	30	0	
								Subtotal Collision Factors		**15**

G + O + E + A = Total Warranting Points	**111**
Warranting Condition	**120**
Difference +/-	**-9**

APPENDIX 39-1

WILDLIFE SUPPLEMENTAL BASELINE REPORT

WILDLIFE SUPPLEMENTAL BASELINE REPORT
FOR THE
CANADIAN NATURAL
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

Prepared for:
Canadian Natural Resources Limited

Prepared by:
Golder Associates Ltd.

December 2012 **12-1346-0014**

Baseline wildlife surveys were completed between 2001 and 2011 to support an Environmental Impact Assessment (EIA) for the Kirby In Situ Oil Sands Expansion Project (the Project). These results can be found in the Wildlife Baseline Report submitted with the Project EIA (Canadian Natural 2011). Surveys completed included:

- ungulate aerial surveys;
- winter track count surveys;
- photographic bait stations;
- beaver/muskrat surveys;
- bat surveys;
- owl surveys;
- marsh bird surveys;
- yellow rail surveys;
- horned grebe surveys;
- breeding songbird surveys (including focused surveys for Canada warbler, olive-sided flycatcher and rusty blackbird);
- common nighthawk surveys; and
- amphibian surveys.

Where access was available, additional winter track count, bat, owl, marsh bird, yellow rail, horned grebe, breeding songbird, common nighthawk, and amphibian surveys were conducted in 2012 to provide more complete coverage of the east central, central and eastern portions of the proposed Project Area (Supplemental Information Request 206 [Canadian Natural 2012]). This supplemental baseline report incorporates the additional data collected in 2012 into the applicable analyses and presents updated results for the aforementioned surveys.

Winter track count surveys were conducted to sample terrestrial carnivores, ungulates and rodents. A total of 127.2 km were surveyed for tracks in 26 different land cover types in and around the Local Study Area (LSA). These surveys recorded Canada lynx, coyote, deer species, fisher/marten, grouse species, grey wolf, mice species, moose, porcupine, ptarmigan, red fox, red squirrel, river otter, snowshoe hare, weasel species and woodland caribou in and around the LSA. Of these species, porcupine and river otter were detected least often, followed by red fox and woodland caribou. The track densities recorded in and around the LSA were generally lower than the ranges recorded on other projects in the Regional

Study Area (RSA), or were at the low end of the range, with the exception of moose, coyote, Canada lynx, and river otter.

During bat capture surveys in and around the LSA, 28 mist-netting sites were operated for a total of 180.0 mist-net hours. Twenty-four bats were captured including 20 little brown myotis and four silver-haired bats. Overall capture success was 0.13 bats per mist-net hour. Ninety-two acoustic detection plots were surveyed for a total of 41.4 detector hours. Ten species/species groups were identified based on call analysis: hoary bat, little brown myotis, northern myotis, red bat, silver-haired bat, big brown/silver-haired bats, little brown/northern myotis, an unknown bat and high and low frequency bats. Bats were detected at an overall frequency of 13.0 passes/hr and 3.2 feeding buzzes/hr. Relative activity was within the range reported for other projects in the RSA.

Owl surveys were conducted at 106 plots in and around the LSA. Forty-one owls, comprising three different species, were documented including 22 boreal owls, three great gray owls and 16 great horned owls. Relative population densities by land cover type ranged from 0.001 to greater than 2 individuals/ha.

One-hundred and four marsh bird plots were surveyed in and around the LSA. A total of 18 soras were detected in five different land cover types. One pied-billed grebe was recorded incidentally.

Yellow rail surveys were conducted at 59 plots in and around the LSA. No yellow rails were detected during these surveys or incidentally. Data from other projects in the RSA are not available for comparison because yellow rail-specific surveys are a recent addition to survey protocols in the Oil Sands Region.

Horned grebe surveys were conducted at 29 plots in and around the LSA. Two horned grebes were detected during these surveys and no additional individuals were recorded incidentally. The ability to make comparisons to other projects in the RSA is limited since horned grebe surveys are a recent addition to survey protocols in the Oil Sands Region.

In total, 364 breeding songbird point counts were completed in and around the LSA. Of these 364 point counts, 119 were conducted in habitats suitable for federally listed species including Canada warbler, olive-sided flycatcher and rusty blackbird. Fifty-three songbird species and 861 individual birds were recorded during the point counts. The five most commonly observed species comprised 50% of all observations. Yellow-rumped warbler was the most commonly detected species, followed by chipping sparrow, dark-eyed junco, alder flycatcher and Tennessee warbler. Ten federally and/or provincially listed songbird species were recorded in and around the LSA, including common yellowthroat, olive-sided flycatcher, least flycatcher, brown creeper, bay-breasted warbler, Cape May warbler, western wood-pewee, western tanager, rusty blackbird and sedge wren.

Thirty-one common nighthawk point counts were completed in and around the LSA. One common nighthawk was recorded during these surveys, and another 22 individuals were detected incidentally. The ability to make comparisons to other projects in the RSA is limited because common nighthawk surveys are a recent addition to survey protocols in the Oil Sands Region.

A total of 173 plots were sampled during amphibian surveys in and around the LSA. Boreal chorus frogs, wood frogs and western toads were detected during all four years of sampling. Boreal chorus frogs were the most numerous, followed by wood frogs. Western toads represented less than 10% of recorded amphibian calls. Breeding evidence was detected at 11 plots; three wood frog egg clusters, one western toad egg cluster and seven unidentified frog species egg clusters. Three tadpole groups were also observed; two were an unidentified toad species and one an unidentified frog species.

Forty-three species of concern were recorded for the Project. These include listed species such as Canada lynx, fisher, hoary bat, little brown myotis, northern myotis, red bat, silver-haired bat, western toad, woodland caribou and 31 bird species. Other species of concern recorded for the Project include beaver, black bear and moose, all of which are considered secure in the province, but are of concern due to their high social, traditional and economic importance. Black bear, fisher and moose are also environmental indicators ratified by the Cumulative Environmental Management Association Sustainable Ecosystem Working Group.

Three bird communities of concern were identified in and around the LSA during field surveys or incidentally. Of these, the old growth forest bird community is a Cumulative Environmental Management Association Sustainable Ecosystem Working Group ratified environmental indicator. Ducks and geese and the mixedwood forest bird community were also identified for the Project and are considered culturally and economically important.

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LIST OF ATTACHMENTS

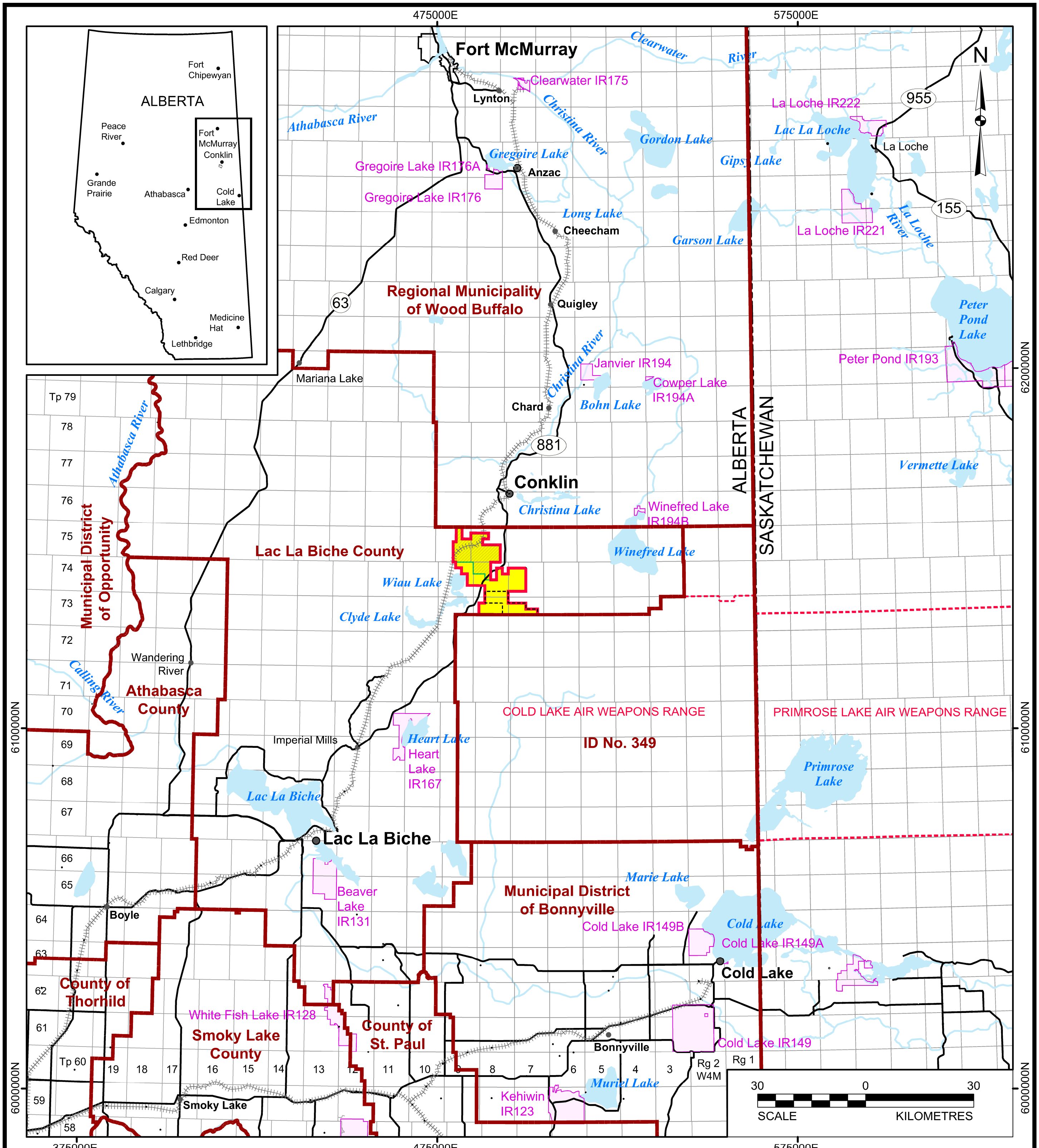
Attachment A Common Names, Scientific Names and Status of Species Observed
Attachment B Potential and Observed Species of Concern
Attachment C Incidental Wildlife Sightings
Attachment D Winter Track Count Results
Attachment E Historic Wildlife Survey Results in the Region
Attachment F Breeding Songbird Results in the Oil Sands Region

1 INTRODUCTION

In December 2011, Canadian Natural Resources Limited (Canadian Natural) applied for approval of the Kirby In Situ Oil Sands Expansion Project (the Kirby Expansion Project or the Project). The Project will involve bitumen production from oil sands formations within a proposed Project Area located in Townships 73, 74 and 75, Ranges 7, 8 and 9, West of the Fourth Meridian (W4M). The Project footprint includes water source and disposal wells and pipelines that extend west of the proposed Project Area into Lac La Biche County (Figure 1). The proposed Project Area consists of 100.75 sections (26,526 ha) of land on which Canadian Natural fully holds the oil sands exploration and development rights.

Results from baseline wildlife surveys completed between 2001 and 2011 in support of the Project's Environmental Impact Assessment (EIA) can be found in the Wildlife Baseline Report provided on CD with the December 2011 Application (Canadian Natural 2011). Baseline information on wildlife, including mammals, birds and amphibians, is required for the impact assessment, as well as mitigation and monitoring program planning. Where access was available, further winter track count, bat, owl, marsh bird, yellow rail, horned grebe, breeding songbird, common nighthawk, and amphibian surveys were conducted in 2012 to provide more complete coverage of the east central, central and eastern portions of the proposed Project Area (Supplemental Information Request [SIR] 206 [Canadian Natural 2012]). This supplemental baseline report incorporates the additional data collected in 2012 into the applicable analyses and presents updated results for the aforementioned surveys. The following attachments contain pertinent information and should be read in conjunction with this supplemental baseline report:

- Attachment A: Common names, scientific names and status of species observed;
- Attachment B: Potential and observed species of concern;
- Attachment C: Incidental wildlife sightings;
- Attachment D: Winter track count results;
- Attachment E: Historical wildlife survey results in the Oil Sands Region; and
- Attachment F: Breeding songbird results in the Oil Sands Region.



LEGEND

- COLD LAKE / PRIMROSE LAKE AIR WEAPONS RANGE BOUNDARY
- RAILWAY
- ROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA
- APPROVED KIRBY SOUTH 2010 PROJECT AREA
- APPROVED KIRBY NORTH 2010 PROJECT AREA

Note

*Includes Oil Sands Leases fully held by Canadian Natural

REFERENCE

ALBERTA NTDB DATA SUPPLIED BY GEOMATICS CANADA, AUGUST 2001. NAD 83 ZONE 12. SHEETS 74D, E AND 74L IN NAD 27 ZONE 12. SASKATCHEWAN NTDB DATA SUPPLIED BY ISC, AUG. 2001. NAD 83 ZONE 13. ALL DATA CONVERTED TO NAD 83 UTM ZONE 12.

PROJECT

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

PROJECT LOCATION

Canadian Natural

PROJECT	12.1346.0014.5900		FILE No.	12134600145900A002
DESIGN	FD	20 Nov. 2012	SCALE AS SHOWN	REV. 0
CADD	PSR	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 1	
REVIEW	JV	11 Dec. 2012		

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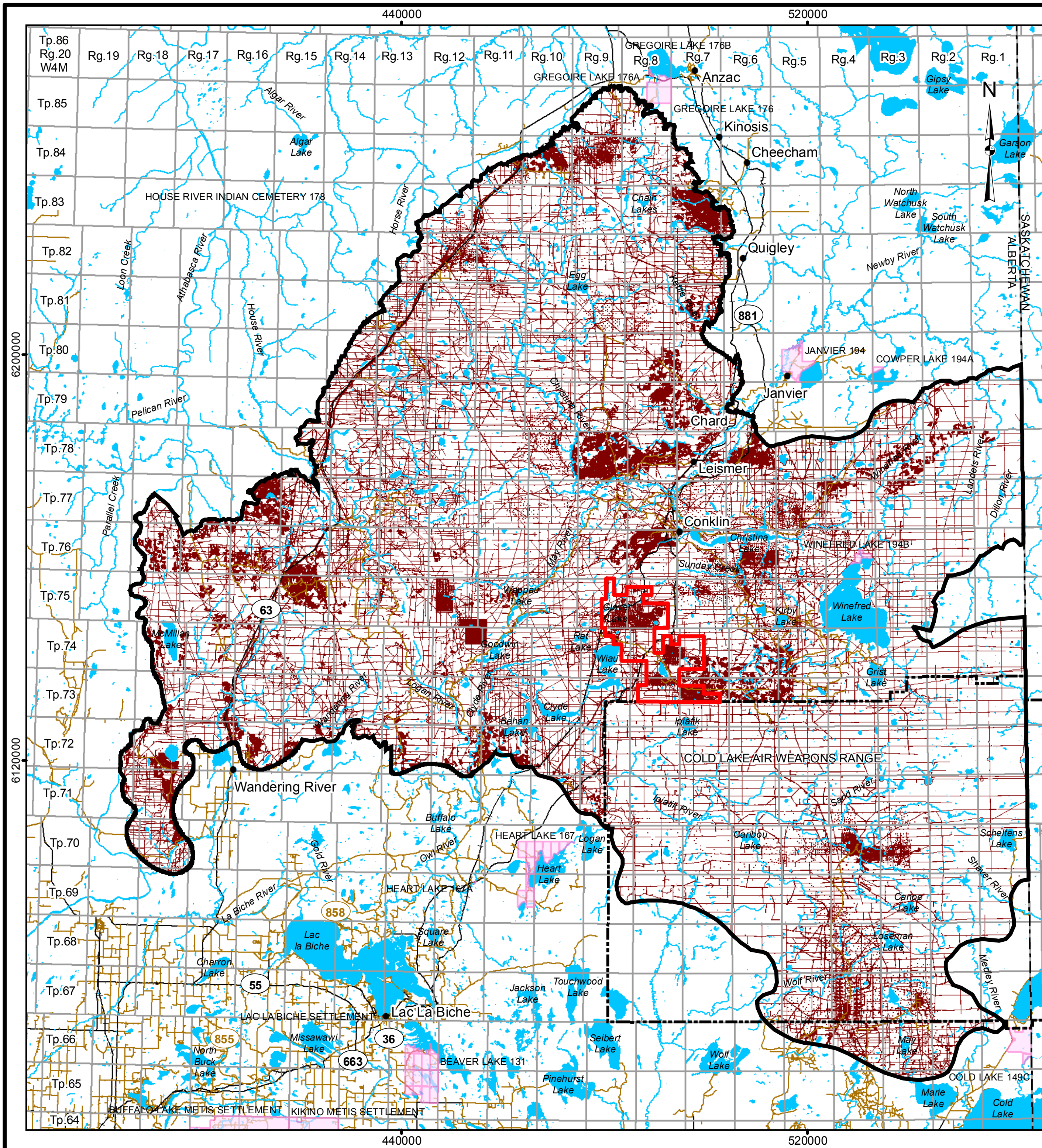
1.1 STUDY OBJECTIVES

The objectives of the wildlife baseline surveys conducted for the Project were to:

- identify wildlife resources that might be affected by the Project;
- identify Key Indicator Resources (KIRs) for the Project; wildlife species used as a focus for the assessment of environmental effects on wildlife and wildlife habitat;
- provide information on presence, relative abundance, distribution, general life history, habitat requirements and habitat use of wildlife potentially affected by the Project, with a focus on KIRs;
- determine whether any provincially or federally listed wildlife species or species with substantial ecological, cultural or economic value (i.e., species of concern) are present in and around the Local Study Area (LSA);
- identify important wildlife habitats, including movement corridors, at both regional and local scales; and
- describe, quantify and map habitat disturbances in the LSA.

1.2 STUDY AREAS

The terrestrial resources Regional Study Area (RSA; Figure 2) and LSA (Figure 3) were developed with consideration of the four terrestrial resources components of the Project (i.e., terrain and soils; terrestrial vegetation, wetlands and forestry; wildlife; and biodiversity) and are identical for all of these components. The RSA covers an area of 18,541 km^2 (1,854,108 ha) and the LSA is 164 km^2 (16,422 ha) in size. Complete descriptions of the RSA and LSA are found in Section 1.2 of the Wildlife Baseline Report (Canadian Natural 2011).



LEGEND

- ● COMMUNITY
- UNPAVED ROAD
- PAVED ROAD
- RAILROAD
- INDIAN RESERVE
- PROPOSED KIRBY EXPANSION PROJECT AREA*
- OPEN WATER
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA

DISTURBANCE

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

35 0 35

SCALE 1:1,100,000 KILOMETRES

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

TERRESTRIAL RESOURCES REGIONAL STUDY AREA

Golder Associates

PROJECT	12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012	
CHECK	JG	11 Dec. 2012	**FIGURE: 2**
REVIEW	JV	11 Dec. 2012	

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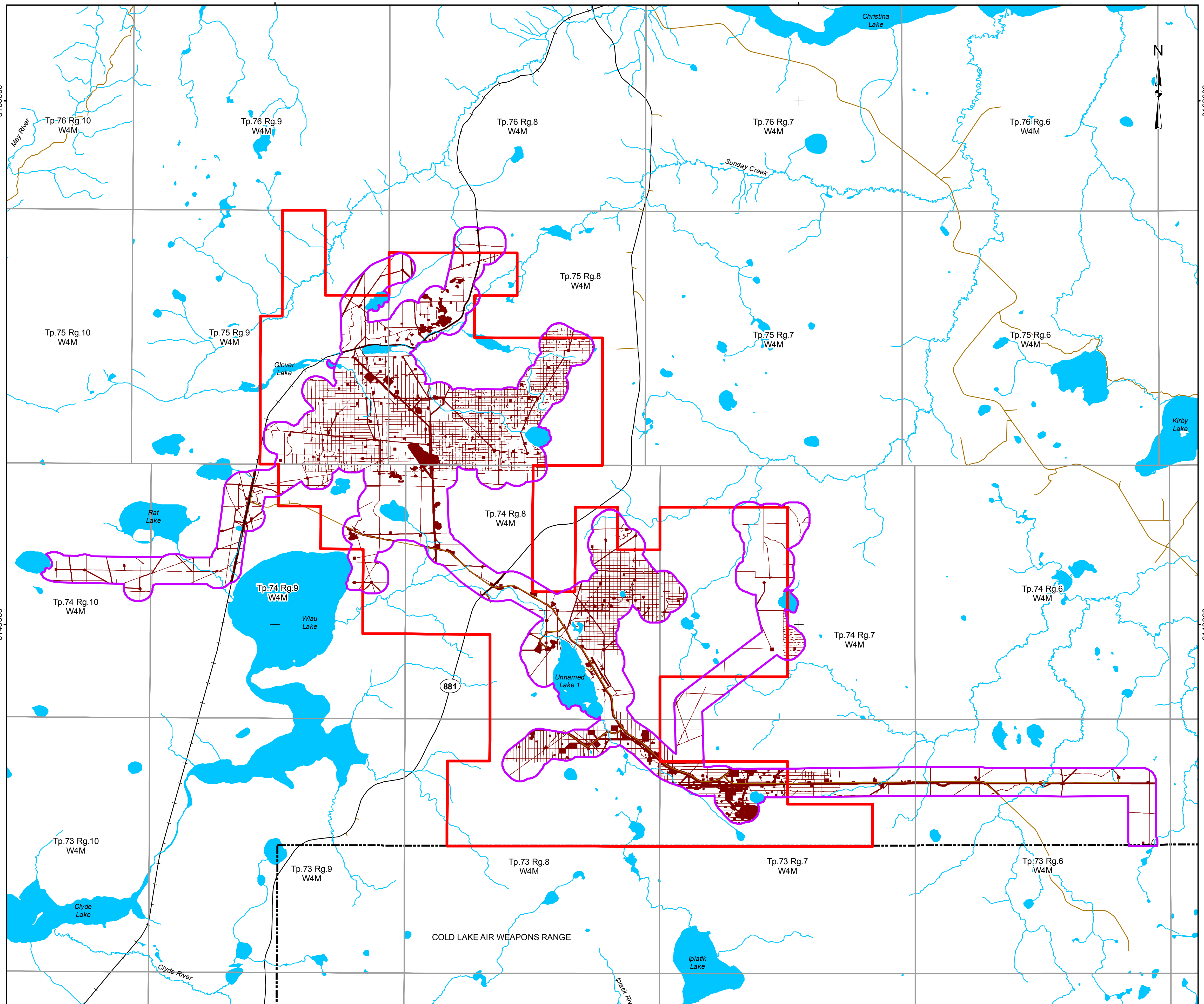

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

DISTURBANCE

- EXISTING AND APPROVED INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED INDUSTRIAL LINEAR DISTURBANCE

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

TERRESTRIAL RESOURCES LOCAL STUDY AREA

Golder Associates

PROJECT		12-1346-0014	FILE No.
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN REV. 0
GIS	GU	21 Nov. 2012	
CHECK	JG	11 Dec. 2012	FIGURE: 3
REVIEW	JV	11 Dec. 2012	

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2 METHODS

Baseline information pertaining to wildlife and wildlife habitat originated from various sources. Data were collected in and around the LSA from 2001 to 2012 according to survey protocols described in Section 2.1 of the Wildlife Baseline Report (Canadian Natural 2011). Data analysis methods are also described in Section 2.1 of the Wildlife Baseline Report. General survey details are summarized in Table 1. Information from previous studies, historical databases (i.e., Fish and Wildlife Management Information System [FWMIS]) and pertinent scientific literature was also reviewed to provide additional context and detail.

Data collection and analysis methods used for the Project are generally consistent with those followed for previous Oil Sands Region EIAs. Data from EIAs completed for other projects in the RSA were used for comparative purposes. These projects included:

- Cenovus FCCL Ltd. (Cenovus) Christina Lake Thermal Project (CLTP) (EnCana 2005, 2009);
- Cenovus Narrows Lake Project (Cenovus 2010);
- Gulf Canada Resources Ltd. Surmont In-Situ Oil Sands Project (Gulf 2001);
- MEG Energy Corp. (MEG) Christina Lake Regional Project (CLRP; MEG 2005, 2008);
- OPTI Canada Inc. Long Lake Project (OPTI 2000); and
- Petro-Canada Oil and Gas (Petro-Canada) Meadow Creek Project (Petro-Canada 2001).

Surveys targeted a variety of wildlife species and guilds, and an attempt was made to focus on species of concern to the extent practical. Federally listed species surveyed included current Committee on the Status of Endangered Wildlife in Canada (COSEWIC) species and species listed on Schedule 1 of the *Species at Risk Act* (SARA) that may reproduce in and around the LSA. These species are listed in Table 2, along with federal status and survey type used to target each species.

Table 1 Wildlife Surveys Conducted in and Around the Local Study Area

Survey Type	Survey Date(s)	Number of Survey Sites/ Length of Transects	Weather Conditions	Survey Locations
amphibian	May 7 to 10 and 21 to 24, 2001	59 plots	Temperatures ranged from -4°C to 17°C, skies from clear to overcast and winds from calm to moderate.	Figure 14
	May 22 to 23 and June 2 to 3, 2008	28 plots		
	June 2 and 4 to 9, 2011	71 plots		
	June 5 to 6, 2012	15 plots		
bat	July 19 to 22, 2001 August 2 to 3, 2008 July 19 to 22, 2011 July 21 to 23, 2012	28 mist-net plots, 180.0 mist-net hours; 92 detector plots, 41.4[(a)] hours monitoring	Temperatures ranged from 8°C to 24°C with little or light wind. Skies ranged from clear to overcast.	Figure 9
beaver/muskrat aerial	October 10, 2001 October 17, 2007 October 28, 2011	3,140 ha of lakes and ponds, 207.5 km of watercourses and shoreline	Temperatures ranged from 0°C to 8°C. Skies ranged from clear to overcast, but visibility was good.	Figures 5 and 6; Wildlife Baseline Report
breeding songbird	June 14 to 16, 2001	113 plots	Temperature ranged from -1°C to 20°C. Winds ranged from light to moderate, gusting to high. Skies ranged from clear to overcast.	Figures 12 and 13
	June 11 to 12, 2008	52 plots		
	June 26 to 30, 2009	57 plots		
	June 14, 15, 17 and 19 to 23, 2011	112 plots (99 targeted species at risk)		
	June 13, 14 and 15, 2012	24 plots (20 targeted species at risk)		
common nighthawk	July 7, 8, 10 and 11, 2011	10 plots	Temperatures ranged from 10°C to 14°C, skies from clear to overcast and winds from calm to moderate.	Figure 13
	June 5 to 6 and July 10 to 11, 2012	21 plots		
horned grebe	June 4 to 6, 8, 9, 14, 17 and 19 to 22, 2011	25 plots	Temperatures ranged from 9°C to 24°C, skies from clear to overcast and winds from calm to moderate.	Figure 11
	June 14 to 15, 2012	4 plots		
marsh bird	May 22 to 23 and June 2 to 3, 2008	28 plots	Temperatures ranged from -4°C to 17°C, skies from clear to overcast and winds from calm to moderate.	Figure 11
	June 4 to 9, 2011	67 plots		
	June 5 to 6, 2012	9 plots		
owl	March 20 to 21, 2001	20 plots	Temperatures ranged from -21°C to -4°C. Skies ranged from clear to overcast, with generally light winds.	Figure 10
	April 17 to 19 and May 1, 2008	22 plots		
	April 13 to 16, 2011	46 plots		
	May 2 to 3, 2012	18 plots		

Table 1 Wildlife Surveys Conducted In and Around the Local Study Area (continued)

Survey Type	Survey Date(s)	Number of Survey Sites/ Length of Transects	Weather Conditions	Survey Locations
photographic bait stations	November 7 to 12, 2006	6 cameras -14 days	Variable	Figure 10; Wildlife Baseline Report
	February 16 to March 7, 2007	6 cameras -19 days		
	May 23 to June 5, 2007	6 cameras - 14 days		
	July 5 to 18, 2007	5 cameras - 13 days		
	October 31 to November 14, 2007	6 cameras -14 days		
	March 18 to April 2, 2008	6 cameras -15 days		
	May 16 to 30, 2008	5 cameras -14 days		
	June 19 to July 3, 2008	6 cameras -14 days		
	February 9 to April 1, 2011	11 cameras - 51 days		
	April 1 to May 22, 2011	11 cameras - 51 days		
	July 11 to September 12, 2011	11 cameras – 63 days		
	October 3 to 28, 2011	11 cameras – 25 days		
ungulate aerial	February 3, 2001	2001: 50 km^2; 50% coverage of lease	Visibility was good or excellent, with 100% snow cover and calm to 15 km/h winds. Temperatures ranged from 5°C to -26°C.	Figures 7 and 8; Wildlife Baseline Report
	March 5, 7 and 8, 2007	2007: 92.4 km^2; 50% coverage of lease		
	February 4, 2008	2008: 139 km^2; 50% coverage of lease		
	February 11 to 14, 2011	2011: 497 km^2; 100% coverage of lease		
winter track counts	February 1 to 5, 2001	47 km of transects	Variable	Figures 4 to 8
	February 22 to 25, 2008	27 km of transects		
	January 29, 2009	9 km of transects		
	March 1, 2009	9 km of transects		
	February 11 to 14, 2011	13.5 km of transects		
	March 8 to 9, 2011	12 km of transects		
	March 22 to 26, 2012	9.7 km of transects		
yellow rail	July 8 to 12, 2011	44 plots	Temperatures ranged from 5°C to 14°C, skies from clear to overcast and wind was light.	Figure 11
	July 10 to 11, 2012	15 plots		

(a) The 2011 Wildlife Baseline Report (Canadian Natural 2011) double-counted some of the acoustic detection plots, therefore monitoring effort appears to have decreased despite conducting additional surveys in 2012.

Table 2 Federally Listed Species At Risk That May Reproduce in and Around the Local Study Area

Common Name	Scientific Name	COSEWIC Status[(a)]	SARA Status[(b)]	Survey Type
Canada warbler	*Wilsonia canadensis*	Threatened	Schedule 1: Threatened	focused point counts in high-quality habitat
common nighthawk	*Chordeiles minor*	Threatened	Schedule 1: Threatened	species-specific point counts
horned grebe (western population)	*Podiceps auritus*	Special Concern	No Schedule: No Status	species-specific call playback
little brown myotis (formerly little brown bat)	*Myotis lucifugus*	Endangered	No Schedule: No Status	capture (mist-netting) and acoustic detection
northern myotis (formerly northern long-eared bat)	*Myotis septentrionalis*	Endangered	No Schedule: No Status	capture (mist-netting) and acoustic detection
olive-sided flycatcher	*Contopus cooperi*	Threatened	Schedule 1: Threatened	focused point counts in high-quality habitat
rusty blackbird	*Eughagus caroinus*	Special Concern	Schedule 1: Special Concern	focused point counts in high-quality habitat
short-eared owl	*Asio flammeus*	Special Concern	Schedule 1: Special Concern	none[(c)]
western toad (formerly boreal toad)	*Anaxyrus boreas* (formerly *Bufo boreas*)	Special Concern	Schedule 1: Special Concern	amphibian call detection
wolverine (western population)	*Gulo gulo*	Special Concern	No Schedule: No Status	photographic bait stations and winter track counts
wood bison	*Bison bison athabascae*	Threatened	Schedule 1: Threatened	ungulate aerial and winter track counts
woodland caribou	*Rangifer tarandus*	Threatened	Schedule 1: Threatened	ungulate aerial and winter track counts
yellow rail	*Coturnicops noveboracensis*	Special Concern	Schedule 1: Special Concern	species-specific call playback

(a) COSEWIC (2012a).

(b) Species at Risk Public Registry (2012).

(c) Adults of this species are generally silent (Wiggins et al. 2006); therefore, standard nocturnal owl survey protocols are inappropriate. The development of an appropriate species-specific protocol has been recommended by the Rare Animals Monitoring Team, Ecological Monitoring Committee for the Lower Athabasca (Fisher et al. 2011), but is not yet available.

3 RESULTS

3.1 WINTER TRACK COUNT SURVEYS

The seven winter track count sessions conducted from 2001 through 2012 result in a combined total of 127.2 linear kilometres of transects surveyed in and around the LSA (Table 1, Figure 4). A total of 315.2 km-days and 26 land cover types were sampled (Table 3).

Table 3 Land Cover Types Sampled During the Winter Track Count Surveys in and Around the Local Study Area, 2001, 2008, 2009, 2011 and 2012

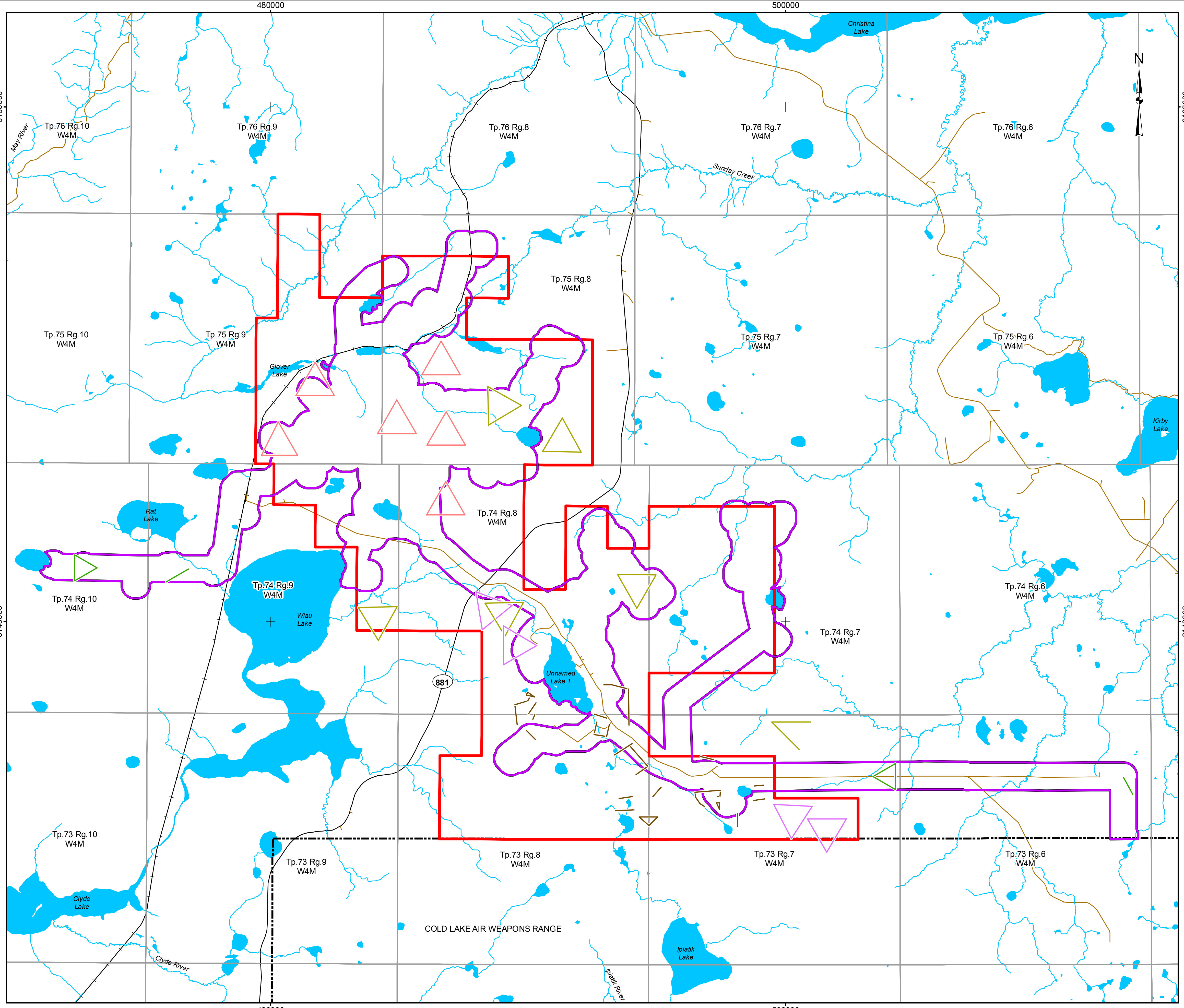
Land Cover Type[(a)]		km-Days Sampled	Tracking Effort [%]
Ecosite Phase			
a1	lichen jack pine	3.4	1.1
b1	blueberry jackpine-aspen	2.6	0.8
b2	blueberry aspen (white birch)	0.9	0.3
b3	blueberry aspen-white spruce	2.6	0.8
b4	blueberry white spruce-jack pine	4.0	1.3
c1	Labrador tea–mesic jack pine-black spruce	15.3	4.9
d1	low-bush cranberry aspen	6.1	1.9
d2	low-bush cranberry aspen-white spruce	8.0	2.5
d3	low-bush cranberry white spruce	0.4	0.1
e2	dogwood balsam poplar-white spruce	0.4	0.1
f1	horsetail balsam poplar-aspen	0.1	<0.1
g1	Labrador tea–subhygric black spruce-jack pine	60.4	19.2
h1	Labrador tea/horesetail white spruce-black spruce	0.7	0.2
	ecosite subtotal	*104.9*	*33.3*
Wetlands Type			
BONS	shrubby bog	3.4	1.1
BTNN	wooded bog	26.7	8.5
FONG	graminoid fen	0.3	0.1
FONS	shrubby fen	13.7	4.3
FTNN	wooded fen	41.1	13.1
MONG	graminoid marsh	1.2	0.4
SONS	shrubby swamp	3.7	1.2
STNN	wooded swamp	3.3	1.0
	wetlands subtotal	*93.4*	*29.6*
Other			
Burn	burn	24.5	7.8
DIS-l	disturbed - linear[(b)]	8.5	2.7
DIS-nl	disturbed - non-linear[(c)]	1.6	0.5
Ice	ice	1.4	0.4
Sh	shrubland	80.9	25.7
	other subtotal	*116.9*	*37.1*
Total		**315.2**	**100.0**

(a) Beckingham and Archibald (1996) and Halsey et al. (2003).

(b) Disturbed-linear types include seismic lines, cutlines and roads.

(c) Disturbed-non-linear types include well pads, clearcuts and other clearings.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- TRANSECT LOCATION (2001)
- TRANSECT LOCATION (2008)
- TRANSECT LOCATION (2009)
- TRANSECT LOCATION (2011)
- TRANSECT LOCATION (2012)

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

WINTER TRACK COUNT SURVEY TRANSECTS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012	**FIGURE: 4**	
CHECK	JG	11 Dec. 2012		
REVIEW	JV	11 Dec. 2012		

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3.1.1 Ungulates

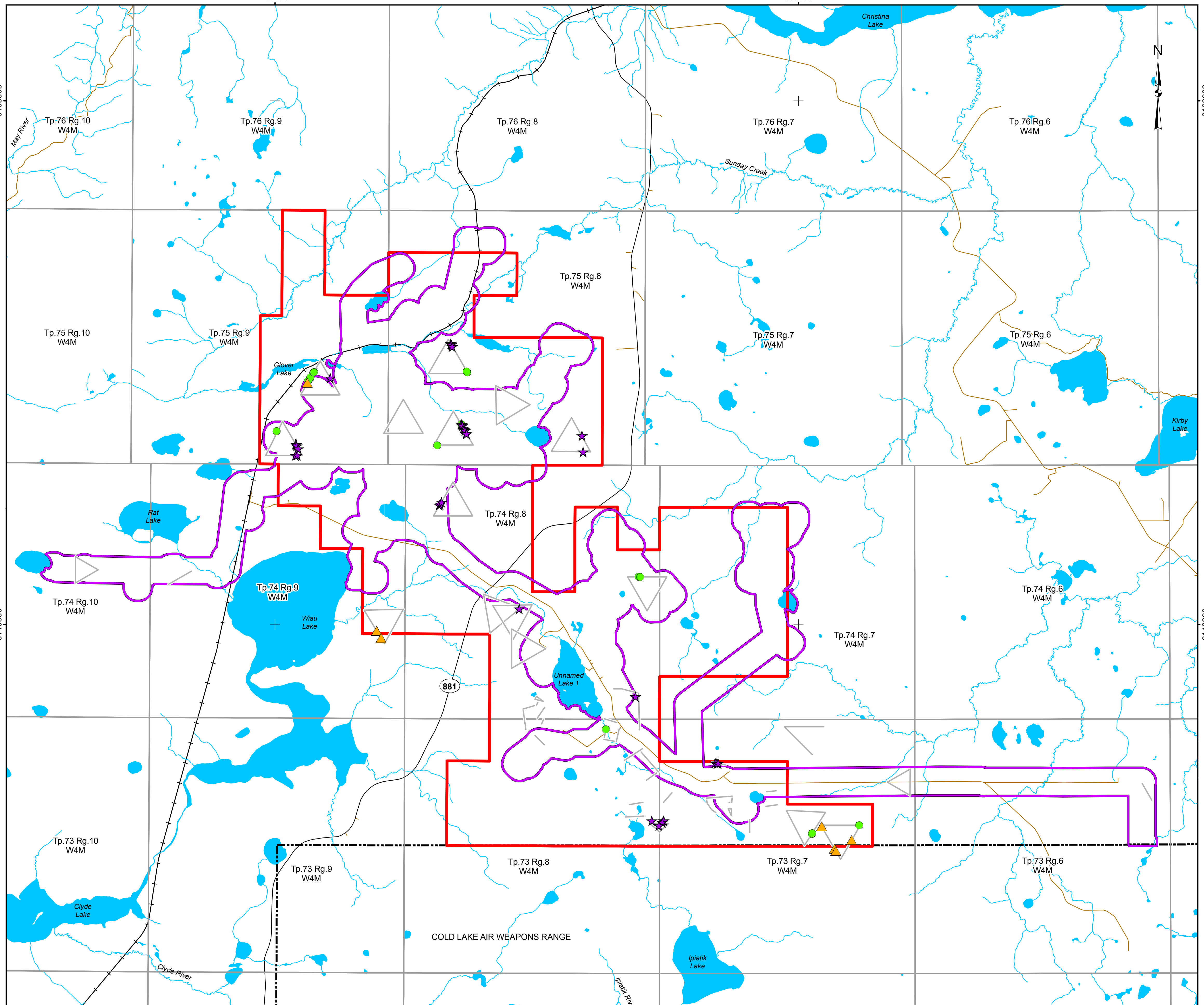
Nineteen caribou tracks were observed during winter track count surveys in and around the LSA resulting in an overall track density of 0.06 tracks/km-day (Figure 5; Attachment D). Caribou track density in the LSA is at the low end of the range reported for other projects in the region (0 to 0.51 caribou/km^2; Attachment E, Table E-9). Caribou tracks were primarily recorded in the wooded bog (BTNN) and shrubby fen (FONS) land cover types and on linear disturbances, with some documented in the Labrador tea-subhygric black spruce-jack pine (g1), shrubland and wooded fen (FTNN) land cover types (Attachment D).

Sixty-four moose tracks were recorded during the winter track count surveys in and around the LSA, resulting in a density of 0.20 tracks/km-day (Figure 5; Attachment D). Track density in the LSA was within the range reported for other projects in the region (0 to 0.52 tracks/km-day; Attachment E, Table E-3). Moose tracks were distributed fairly evenly between upland and wetlands land cover types. The majority of observations occurred in wooded swamp (STNN) and blueberry aspen-white spruce (b3) land cover types (i.e., 2.72 and 1.91 tracks/km-day, respectively; Attachment D).

Forty-two deer tracks were observed in and around the LSA during winter track count surveys for a density of 0.13 tracks/km-day (Figure 5; Attachment D). Track density is below the range of 0.20 to 1.35 tracks/km-day reported by other studies in the region (Attachment E, Table E-6). Deer tracks were observed in 13 land cover types, with the highest track densities recorded in Labrador tea/horsetail white spruce-black spruce (h1), blueberry white spruce-jack pine (b4) and wooded swamp (STNN) (i.e., 2.68, 2.26 and 1.82 tracks/km-day, respectively; Attachment D).

3.1.2 Canids (Dogs)

Twenty-seven wolf tracks were observed during the winter track count surveys in and around the LSA for a track density of 0.09 tracks/km-day (Figure 6; Attachment D). This density is at the low end of the range recorded for other projects in the region (i.e., 0 to 0.23 tracks/km-day; Attachment E, Table E-11). The wolf tracks were observed in the low-bush cranberry aspen-white spruce (d2), shrubby fen (FONS), wooded fen (FTNN), shrubland, Labrador tea-subhygric black spruce-jack pine (g1) treed swamp (STNN) and shrubland land cover types. The highest track densities were recorded in blueberry aspen (white birch) (b2) and on linear disturbances (3.32 and 1.29 tracks/km-day, respectively; Attachment D).



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- WINTER TRACK TRANSECT LOCATION

SPECIES OBSERVATIONS

- DEER SPECIES
- MOOSE
- WOODLAND CARIBOU

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

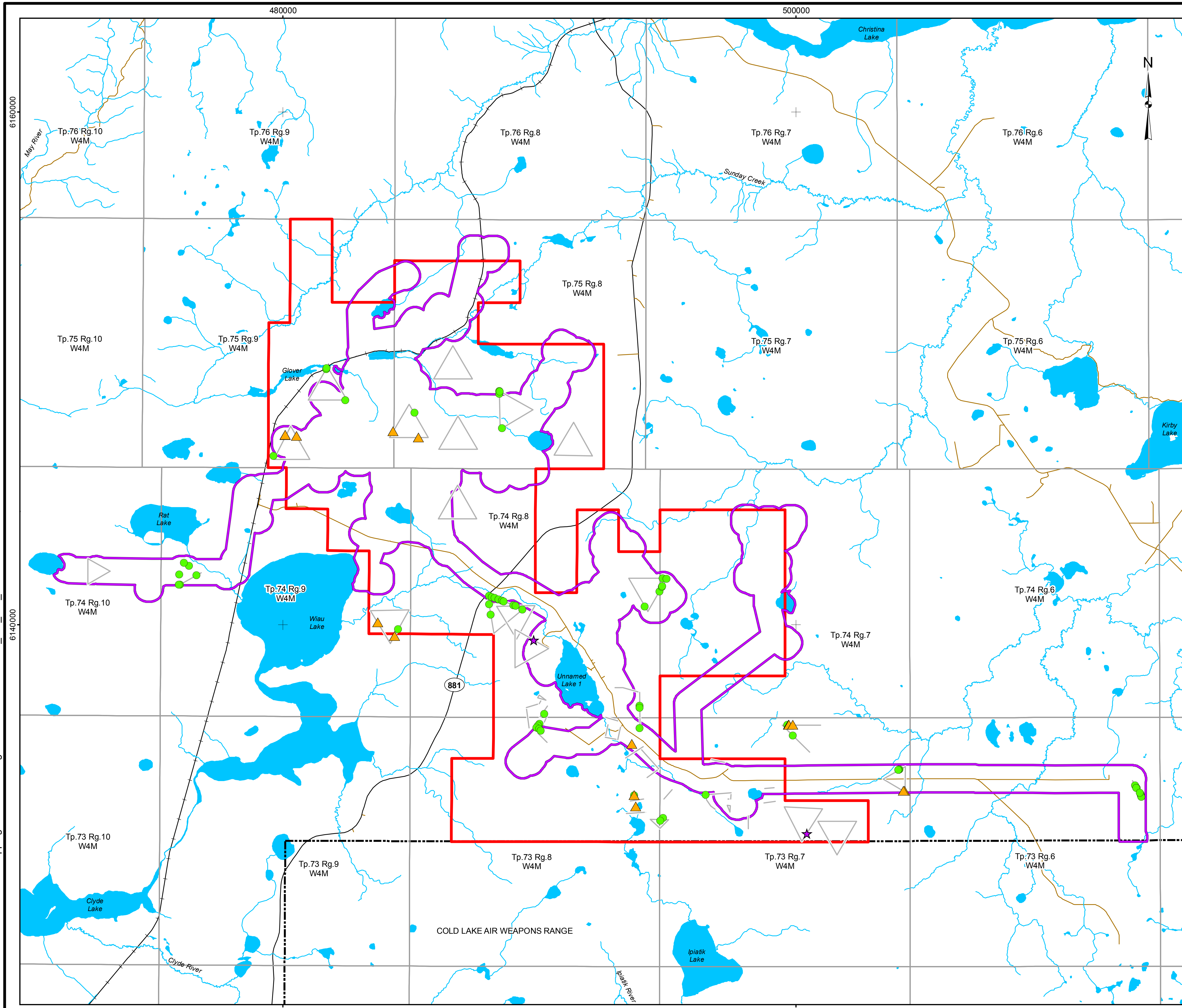
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

UNGULATE TRACK LOCATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 5	
REVIEW	JV	11 Dec. 2012		



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LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- WINTER TRACK TRANSECT LOCATION

SPECIES OBSERVATIONS

- COYOTE
- RED FOX
- WOLF

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

CANID TRACK LOCATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012	**FIGURE: 6**	
CHECK	JG	11 Dec. 2012		
REVIEW	JV	11 Dec. 2012		

Eighty-five coyote tracks were observed during winter track count surveys in and around the LSA, resulting in a track density of 0.27 tracks/km-day (Figure 6; Attachment D). This density is within the range of track densities reported for other projects in the area (0.09 to 0.57 track/km-day; Attachment E, Table E-13). Coyote tracks were observed in 15 land cover types, with the highest track densities recorded in blueberry aspen (white birch) (b2), low-bush cranberry white spruce (d3) and on linear disturbances (3.32, 2.52 and 1.65 tracks/km-day, respectively; Attachment D).

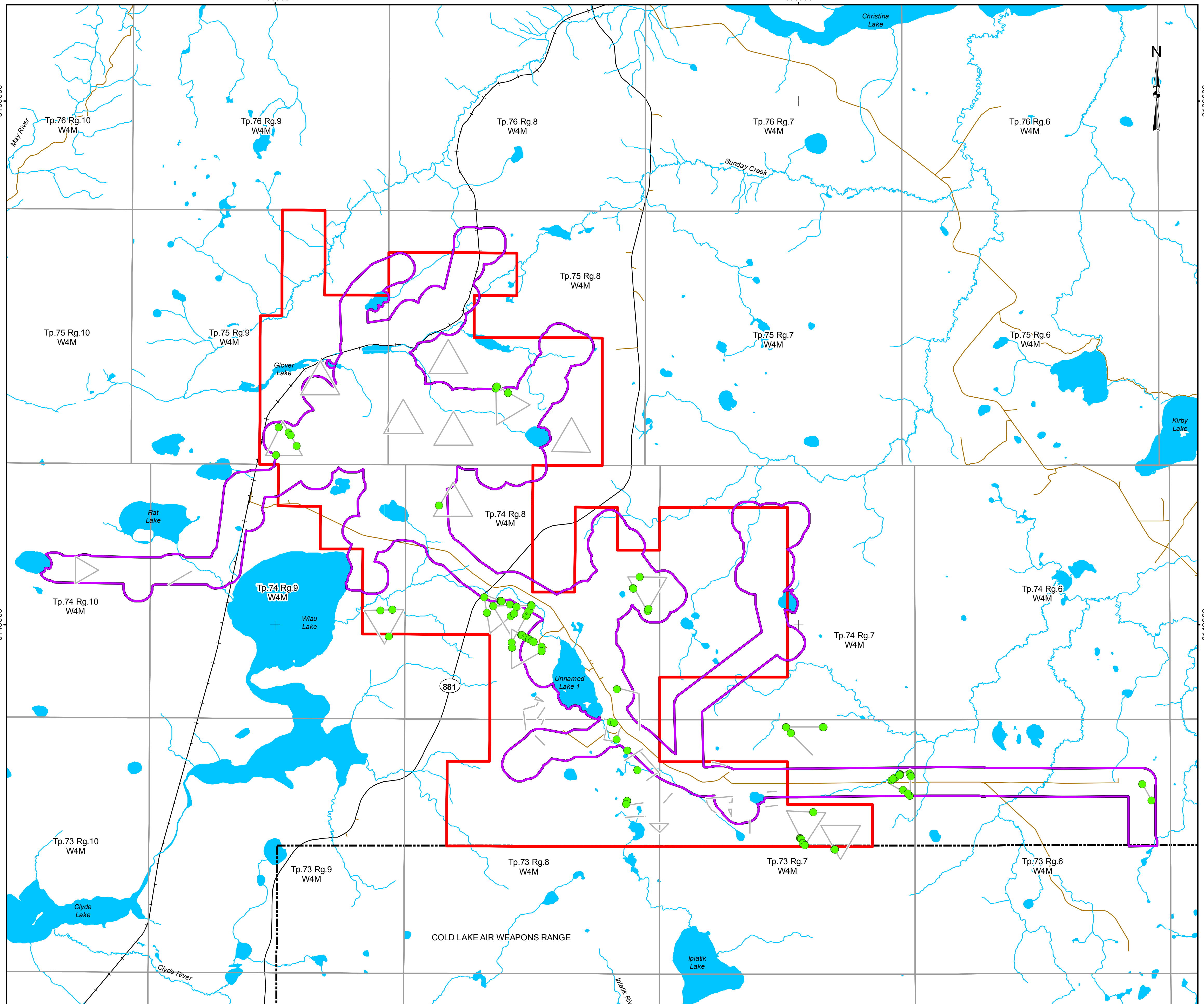
Two red fox tracks were observed during the winter track count surveys in and around the LSA for a track density of 0.01 tracks/km-day (Figure 6; Attachment D). This density is at the lower end of the range reported for other projects in the area (0.01 to 0.36 tracks/km-day; Attachment E, Table E-15). Red fox tracks were observed once in both Labrador tea/horsetail white spruce-black spruce (h1) and Labrador tea mesic jack pine-black spruce (c1) land cover types, yielding track densities of 1.34 and 0.08 tracks/km-day, respectively (Attachment D).

3.1.3 Felids (Cats)

During winter track count surveys, Canada lynx tracks were recorded 120 times in and around the LSA for a track density of 0.38 tracks/km-day (Figure 7; Attachment D). Lynx track density in the LSA was within range reported regionally, with densities found during other surveys as low as 0.06 tracks/km-day (Enerplus 2008) and as high as 0.50 tracks/km-day (OPTI 2000; Attachment E, Table E-17). Canada lynx tracks were observed in 14 different land cover types, with the highest track density observed on linear disturbances, followed by Labrador tea/horsetail white spruce-black spruce (h1) and wooded bog (BTNN) land cover types (1.65, 1.34 and 1.13 tracks/km-day, respectively; Attachment D).

3.1.4 Mustelids (Weasel Family)

In and around the LSA, a total of 44 combined fisher and marten tracks were recorded, for a density of 0.14 tracks/km-day (Figure 8; Attachment D). This density is below the range reported by other projects in the Oil Sands Region (0.97 to 2.44 tracks/km-day; Attachment E, Table E-23). Tracks for fisher/marten were observed in a variety of land cover types in the LSA. Track densities were highest in uplands, with the greatest density observed in the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase (2.68 tracks/km-day; Attachment D).



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- WINTER TRACK TRANSECT LOCATION

SPECIES OBSERVATIONS

- LYNX

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
LYNX TRACK LOCATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 7	
REVIEW	JV	11 Dec. 2012		

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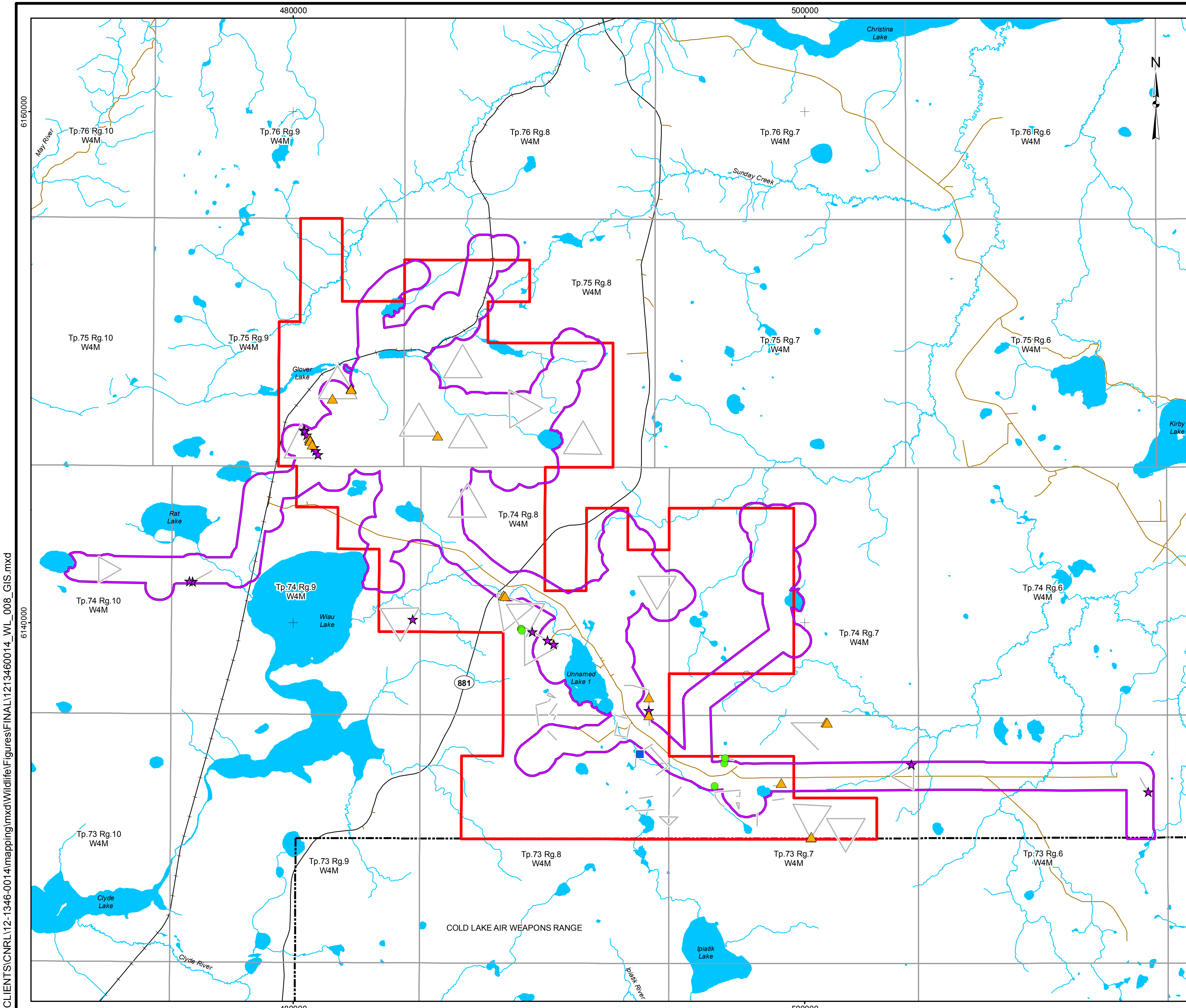


LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- WINTER TRACK TRANSECT LOCATION

SPECIES OBSERVATIONS

- FISHER
- FISHER / MARTEN
- MARTEN
- RIVER OTTER

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), AND FROM IHS ENERGY INC. ALBERTA VEGETATION INVENTORY OBTAINED FROM ALBERTA PACIFIC LTD. (2007, 2011).
DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

FISHER/MARTEN AND RIVER OTTER TRACK LOCATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2009, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 8	
REVIEW	JV	11 Dec. 2012		

Least and short-tailed weasel tracks were recorded 117 times during the winter track count surveys in and around the LSA, for an overall track density of 0.37 tracks/km-day (Attachment D). This track density was at the lower end of the range reported by previous surveys in the RSA, which varied widely from 0.35 tracks/km-day at the MEG Christina Lake Regional Project (MEG 2005) to 1.78 tracks/km-day at the Cenovus Christina Lake Thermal Expansion Project (EnCana 2009; Attachment E, Table E-26). The majority of the weasel tracks observed in the LSA were recorded in wooded bog (BTNN) and shrubby fen (FONS) wetlands types (0.83 and 0.66 tracks/km-day, respectively; Attachment D).

River otter tracks were recorded once in and around the LSA for an overall track density of less than 0.01 tracks/km-day (Figure 8, Attachment D). Track densities from previous surveys in the area were also low, ranging from no observations to a maximum of 0.1 tracks/km-day on the Surmont In-Situ Oil Sands Project (Gulf 2001; Attachment E, Table E-30). The one set of river otter tracks were recorded on ice in the LSA (0.73 tracks/km-day; Attachment D).

3.2 BAT SURVEYS

3.2.1 Capture

During bat surveys conducted in and around the LSA from 2001 through 2012, 28 mist-netting sites were operated along cutlines in 10 different land cover types for a total of 180.0 mist-net hours (Tables 1 and 4, Figure 9). Twenty-four bats were captured; 20 little brown myotis and four silver-haired bats (Table 4). Overall capture success rate was 0.13 bats per mist-net hour. Approximately 63% of the bats were captured along cutlines in either low-bush cranberry aspen-white spruce (d2) or wooded fen (FTNN) land cover types (Table 4). The remaining captures were distributed among the dogwood balsam poplar-white spruce (e2), low-bush cranberry aspen (d1), Labrador tea–mesic jack pine-black spruce (c1) and blueberry jack pine-aspen (b1) ecosite phases (Table 4).

The capture success rate was similar to that reported by other projects in the RSA. For example, rates of 0.24 bats per mist-net hour (Gulf 2001), 0.1 bats per mist-net hour (Cenovus 2010), and 0.2 bats per mist-net hour (EnCana 2009) were reported (Attachment E; Table E-34). The captures on other surveys conducted in the RSA occurred in similar habitats to those captured in the LSA, such as low-bush cranberry aspen-white spruce (d2) (Attachment E; Table E-34).

Table 4 Survey Effort and Capture Success for Bat Surveys In and Around the Local Study Area, 2001, 2008, 2011 and 2012

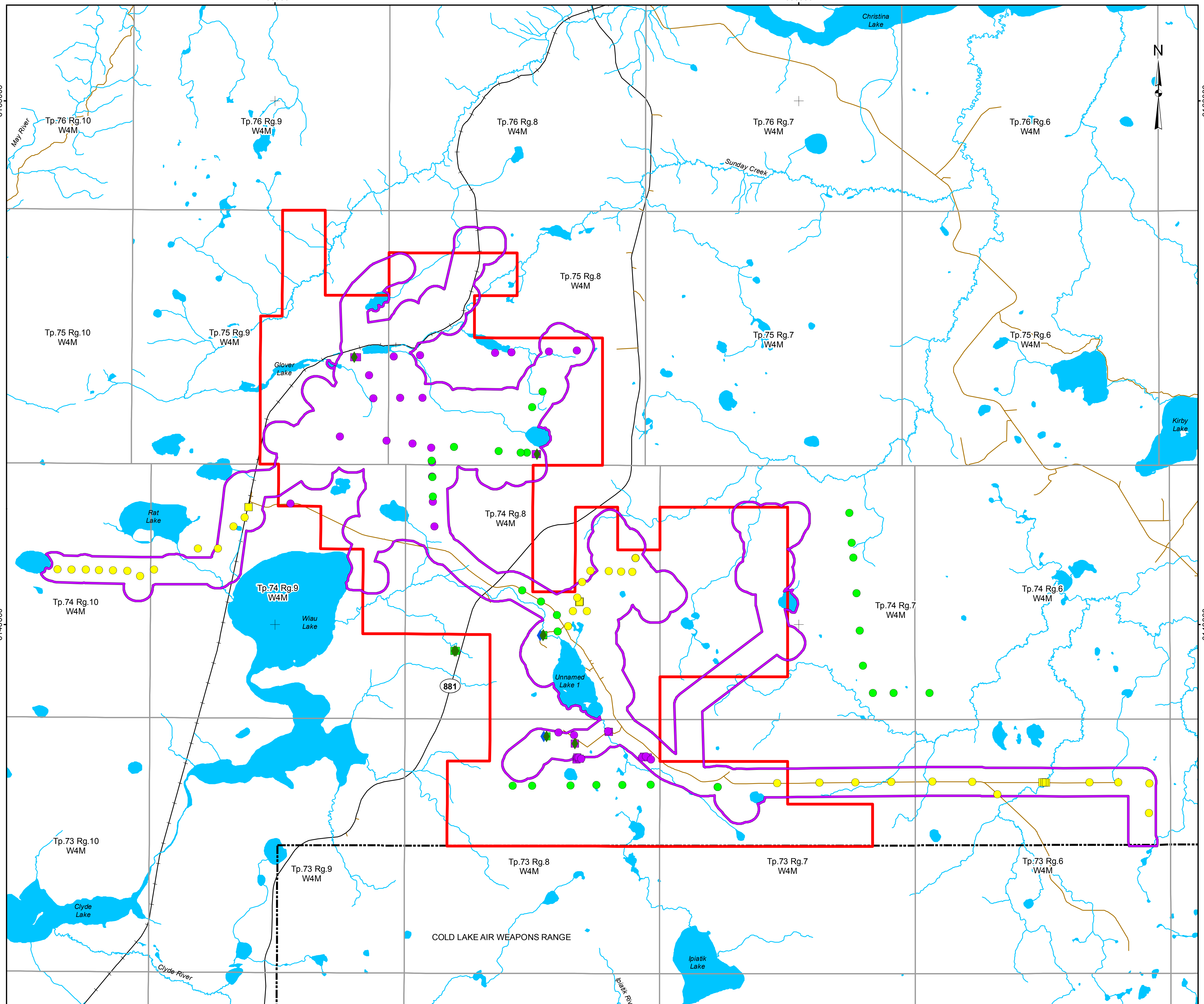
Land Cover Type[(a)]		Survey Effort		Captures[(b)]				
		Mist-Net Plots	Mist-Net Hours[(c)]	Little Brown Myotis		Silver-haired Bat		Total
				Female	Male	Female	Male	
Ecosite Phase								
b1	blueberry jack pine - aspen	1	14.7	1, J, NR	-	-	-	1
c1	Labrador tea-mesic jack pine-black spruce	2	12.7	1, J, NR 1, J, PostL	-	-	-	2
d1	low-bush cranberry aspen cutline	2	15.8	1, A, Lac	1, A, NR	-	-	2
d2	low-bush cranberry aspen-white spruce	4	26.6	2, A, NR 3, J, NR	1, J, NR	2, A, PostL 1, A, NR	-	9
e2	dogwood balsam poplar-white spruce	5	27.3	1, A, NR 1,A, PostL 2, J, NR	-	-	-	4
g1	Labrador tea-hygric black spruce-jack pine	3	20.3	-	-	-	-	0
Wetlands Type								
FTNN	wooded fen	2	13.1	1, A, NR 2, A, PostL	2, A, NR	1, A, NR	-	6
SONS	shrubby swamp	3	15.0	-	-	-	-	0
Other								
burn	burn	1	6.3	-	-	-	-	0
DIS	disturbed	5	28.2	-	-	-	-	0
Total		**28**	**180.0**	**16**	**4**	**4**	**0**	**24**

(a) Beckingham and Archibald (1996). All nets were located on cutlines within the specified ecosite phase.

(b) A = adult; J = juvenile; Lac = lactating; NR = not reproductively active this season; PostL = post-lactating; and R = reproductively active.

(c) Mist-net hours were calculated based on the number of active hours per 6-m-wide net. For example, a single 6-m-wide net open for two hours equals two mist net hours, or a double-high 6-m-wide net open for two hours equals four mist net hours.

- = No captures in category.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

PLOT LOCATIONS

- DETECTOR (2012)
- DETECTOR (2011)
- DETECTOR (PRE-2011)
- NET (2012)
- NET (2011)
- NET (PRE-2011)

SPECIES CAPTURES

- LITTLE BROWN MYOTIS
- SILVER-HAIRED BAT

NOTE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
BAT SURVEY LOCATIONS AND CAPTURES IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2011 AND 2012

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 9	
REVIEW	JV	11 Dec. 2012		

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3.2.2 Acoustic Detection

In addition to mist-netting, 92 acoustic detection plots were surveyed in 16 land cover types for a total of 41.4 detector hours (Tables 5 and 6). The 2011 Wildlife Baseline Report (Canadian Natural 2011) double-counted some of the acoustic detection plots; therefore, detector effort appears to have decreased despite conducting additional surveys in 2012. Ten species/species groups were identified based on call analysis (Tables 5 and 6). A total of 539 bat passes were detected during all sampling sessions combined. Bats were detected at an overall frequency of 13.0 passes/hr (Table 5) and 3.2 feeding buzzes/hr (Table 6). The little brown/northern myotis bat group was the most frequently detected (7.4 passes/hr), followed by little brown myotis (2.4 passes/hr) (Table 5). Foraging activity, as represented by feeding buzzes, was detected for the big brown/silver haired bat, low frequency bat, little brown myotis, northern myotis and the little brown/northern myotis bat species groups. The most frequent foraging activity, 2.3 feeding buzzes/hr, was detected in the little brown/northern myotis bat species group (Table 6).

Although the literature suggests that bats generally prefer upland habitats in the boreal forest, the highest bat activity (passes) in and around the LSA was recorded in the graminoid fen (FONG) wetlands type (54 passes/hr), followed by the wooded bog (BTNN) wetlands type (44 passes/hr; Table 5).

Foraging activity was detected in seven of the 16 sampled land cover types (approximately 44%) (Table 6). The greatest foraging activity was recorded in the graminoid fen (FONG) wetlands type (22.3 buzzes/hr), followed by the wooded bog (BTNN) wetlands type (10.2 buzzes/hr) (Table 6).

Relative activity was similar to what other projects in the RSA have reported (2.2 to 15.2 passes/hr, 0 to 2.9 buzzes/hr; Attachment E, Table E-34). However, the surveys conducted on those other projects recorded most activity in low-bush cranberry ecosite phases (d1 and d2), rather than wetlands types (Attachment E, Table E-34).

Table 5 Survey Effort and Number of Passes Produced by Bats Detected in and Around the Local Study Area, 2001, 2008, 2011 and 2012

Land Cover Type[a]		Survey Effort		Big Brown/ Silver-haired Bat[b]	High Frequency Bat[c]	Hoary Bat	Little Brown Myotis	Little Brown/ Northern Myotis[d]	Low Frequency Bat[e]	Northern Myotis	Red Bat	Silver-haired Bat	Unknown Bat	All Bat Species
		Detector Plots	Detector Hours	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr	passes/hr
Ecosite Phase														
b1	blueberry jack pine-aspen	2	0.3	3.0	-	-	3.0	-	-	-	-	-	-	6.0
b4	blueberry white spruce-jack pine	1	0.2	-	-	-	6.0	-	-	-	-	-	-	6.0
c1	Labrador tea-mesic jack pine-black spruce	7	1.2	1.7	-	-	-	3.4	-	0.9	-	0.9	-	6.9
d1	low-bush cranberry aspen	5	4.3	1.6	-	-	1.8	0.5	0.5	0.2	-	-	-	4.6
d2	low-bush cranberry aspen-white spruce	2	6.5	-	-	-	-	-	-	-	-	-	-	0.0
e1	dogwood balsam poplar-aspen	2	0.3	-	3.0	-	-	-	3.0	-	-	-	-	6.0
e2	dogwood balsam poplar-white spruce	2	5.5	-	-	-	0.9	3.5	6.2	-	-	-	-	10.5
g1	Labrador tea–subhygric black spruce-jack pine	5	0.8	2.4	-	1.2	1.2	1.2	-	-	-	-	-	6.0
Wetlands Type														
BTNN	wooded bog	1	2.8	-	-	-	8.0	36.0	-	-	-	-	-	44.0
FONG	graminoid fen	2	4.2	-	0.2	-	12.0	36.2	5.5	-	-	-	-	54.0
FONS	shrubby fen	1	2.8	-	-	-	0.4	0.4	0.7	-	-	-	-	1.5
FTNN	wooded fen	11	1.8	-	0.6	-	1.1	-	-	-	-	-	-	1.7
SONS	shrubby swamp	2	2.9	6.0	-	-	1.5	9.5	8.0	-	-	-	-	24.9
STNN	wooded swamp	2	0.3	-	-	-	-	-	-	-	-	-	-	6.0
Other														
Burn	burn	19	2.9	2.1	0.7	-	-	0.3	0.3	1.0	0.7	-	0.3	5.5
DIS	disturbed	28	4.7	1.3	0.6	0.4	0.9	0.4	0.2	-	-	0.6	-	4.5
Overall Total or Frequency		**92**	**41.4**	**0.6**	**0.2**	**0.1**	**2.4**	**7.4**	**2.1**	**0.1**	**0.0**	**0.1**	**0.0**	**13.0**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).
(b) Due to overlap in call characteristics, big brown and silver-haired bats could not always be differentiated; however, silver-haired bats are more likely to occur in the area than big brown bats.
(c) Due to overlap in call characteristics, red bats, little brown and northern myotis could not always be differentiated.
(d) Due to overlap in call characteristics, little brown and northern myotis could not always be differentiated.
(e) Due to overlap in call characteristics, hoary, big brown and silver-haired bats could not always be differentiated; however, hoary and silver-haired bats are more likely to occur in the area than big brown bats.
- = No detections in category.
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 6 Survey Effort and Number of Feeding Buzzes Produced by Bats Detected in and Around the Local Study Area, 2001, 2008, 2011 and 2012

Land Cover Type[(a)]		Survey Effort		Big Brown/ Silver-Haired Bat[(b)]	High Frequency Bat[(c)]	Hoary Bat	Little Brown Myotis	Little Brown/ Northern Myotis[(d)]	Low Frequency Bat[(e)]	Northern Myotis	Red Bat	Silver-Haired Bat	Unknown Bat	All Bat Species
		Detector Plots	Detector Hours	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr	buzzes/hr
Ecosite Phase														
b1	blueberry jack pine-aspen	2	0.3	-	-	-	-	-	-	-	-	-	-	0.0
b4	blueberry white spruce-jack pine	1	0.2	-	-	-	-	-	-	-	-	-	-	0.0
c1	Labrador tea-mesic jack pine-black spruce	7	1.2	-	-	-	-	-	-	1.7	-	-	-	1.7
d1	low-bush cranberry aspen	5	4.3	-	-	-	-	-	-	-	-	-	-	0.0
d2	low-bush cranberry aspen-white spruce	2	6.5	-	-	-	-	-	-	-	-	-	-	0.0
e1	dogwood balsam poplar-aspen	2	0.3	-	-	-	-	-	-	-	-	-	-	0.0
e2	dogwood balsam poplar-white spruce	2	5.5	-	-	-	-	0.2	-	-	-	-	-	0.2
g1	Labrador tea–subhygric black spruce-jack pine	5	0.8	-	-	-	-	-	-	-	-	-	-	0.0
Wetlands Type														
BTNN	wooded bog	1	2.8	-	-	-	1.5	8.7	-	-	-	-	-	10.2
FONG	graminoid fen	2	4.2	-	-	-	5.3	16.3	0.7	-	-	-	-	22.3
FONS	shrubby fen	1	2.8	-	-	-	-	-	-	-	-	-	-	0.0
FTNN	wooded fen	11	1.8	-	-	-	-	-	-	-	-	-	-	0.0
SONS	shrubby swamp	2	2.9	-	-	-	-	-	1.1	-	-	-	-	1.1
STNN	wooded swamp	2	0.3	-	-	-	-	-	-	-	-	-	-	0.0
Other														
Burn	burn	19	2.9	0.3	-	-	-	-	-	-	-	-	-	0.3
DIS	disturbed	28	4.7	-	-	-	-	0.2	-	-	-	0.4	-	0.6
Overall Total or Frequency		**92**	**41.4**	**0.0**	**0.0**	**0.0**	**0.6**	**2.3**	**0.1**	**0.0**	**0.00**	**0.0**	**0.0**	**3.2**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Due to overlap in call characteristics, big brown and silver-haired bats could not always be differentiated; however, silver-haired bats are more likely to occur in the area than big brown bats.

(c) Due to overlap in call characteristics, red bats, little brown and northern myotis could not always be differentiated.

(d) Due to overlap in call characteristics, little brown and northern myotis could not always be differentiated.

(e) Due to overlap in call characteristics, hoary, big brown and silver-haired bats could not always be differentiated; however, hoary and silver-haired bats are more likely to occur in the area than big brown bats.

- = No detections in category.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.3 OWL SURVEYS

A total of 106 plots were sampled during owl surveys conducted in and around the LSA between 2001 and 2012 (Table 1, Figure 10). Thirty-two different land cover types were sampled, including 13 ecosite phases, 12 wetlands types and 7 other land cover types (Table 7). Considering an 800-m listening radius around the plot centre and discounting for some effort overlap within survey years; this equates to 20,348 ha (Table 7). Forty-one owls were recorded, comprising three species, including 22 boreal owls, three great gray owls and 16 great horned owls (Table 7). Great gray owls were only detected during the 2011 owl surveys.

Boreal owls were recorded in 31% of the ecosite phases, 42% of the wetlands types and 57% of the other land cover types surveyed (Table 7). Relative boreal owl density (number of boreal owls detected/ha sampled) was highest in the forested fen (FFNN) wetlands type (Table 7). In general, relative densities of boreal owls were higher in wetlands than in upland or other land cover types.

Great gray owls were recorded in no upland ecosite phases, 8% of the wetlands types and 14% of the other land cover types surveyed (Table 7). Relative great gray owl density (number of great gray owls detected/ha sampled) was highest in the wooded fen with internal lawns (FTNI) wetlands type (Table 7).

Great horned owls were recorded in 31% of the upland ecosite phases, 25% of the wetlands types and none of the other land cover types surveyed (Table 7). Relative great horned owl density (number of great horned owls detected/ha sampled) was highest in the forested fen (FFNN) wetlands type. In general, relative densities of great horned owls were higher in wetlands than in upland or other land cover types.

Observed owl species richness in and around the LSA was generally low compared to other projects within the RSA (Attachment E, Table E-24). For example, four owl species were observed on the Surmont In-Situ Oil Sands Project (Gulf 2001), five on the Narrows Lake Project (Cenovus 2010), and six species on the Christina Lake Thermal Expansion Project (EnCana 2009). All three of these other projects reported barred owls, and two reported long-eared and northern saw-whet owls (Attachment E, Table E-24); no individuals of these species were detected during the owl surveys conducted for the Project.

Table 7 Owl Survey Sampling Effort, Observations and Estimated Population Densities in and Around the Local Study Area, 2001, 2008, 2011 and 2012

Map Code	Land Cover Type[(a)]	Total Area Sampled [ha][(b)]	Number of Individuals Detected			Relative Population Density [Individuals/ha][(c)]		
			Boreal Owl	Great Gray Owl	Great Horned Owl	Boreal Owl	Great Gray Owl	Great Horned Owl
Ecosite Phase								
a1	lichen jack pine	357	-	-	1	-	-	0.003
b1	blueberry jackpine-aspen	502	2	-	-	0.004	-	-
b2	blueberry aspen (white birch)	143	1	-	-	0.007	-	-
b3	blueberry aspen-white spruce	56	-	-	-	-	-	-
b4	blueberry white spruce-jack pine	39	-	-	-	-	-	-
c1	Labrador tea–mesic jack pine-black spruce	2,272	2	-	3	0.001	-	0.001
d1	low-bush cranberry aspen	775	1	-	2	0.001	-	0.003
d2	low-bush cranberry aspen-white spruce	163	-	-	-	-	-	-
d3	low-bush cranberry white spruce	37	-	-	-	-	-	-
e1	dogwood balsam poplar-aspen	7	-	-	-	-	-	-
e2	dogwood balsam poplar-white spruce	59	-	-	-	-	-	-
g1	Labrador tea–subhygric black spruce-jack pine	1,516	-	-	2	-	-	0.001
h1	Labrador tea/horesetail white spruce-black spruce	38	-	-	-	-	-	-
	ecosite subtotal	*5,963*	*6*	*-*	*8*	*n/a*	*n/a*	*n/a*
Wetlands Type								
BTNI	wooded bog with internal lawns	24	-	-	-	-	-	-
BTNN	wooded bog	1,374	1	-	-	0.001	-	-
FFNN	forested fen	1	2	-	2	2.143	-	2.143
FONG	graminoid fen	1,328	2	-	1	0.002	-	0.001
FONS	shrubby fen	1,731	-	-	-	-	-	-
FTNI	wooded fen with internal lawns	111	2	1	5	0.018	0.009	0.045
FTNN	wooded fen	2,216	-	-	-	-	-	-
FTPN	wooded patterned fen	13	-	-	-	-	-	-
MONG	graminoid marsh	37	1	-	-	0.027	-	-
SONS	shrubby swamp	107	-	-	-	-	-	-
STNN	wooded swamp	221	-	-	-	-	-	-
WONN	open water	43	-	-	-	-	-	-
	wetlands subtotal	*7,207*	*8*	*1*	*8*	*n/a*	*n/a*	*n/a*

Table 7 Owl Survey Sampling Effort, Observations and Estimated Population Densities in and Around the Local Study Area, 2001, 2008, 2011 and 2012 (continued)

Map Code	Land Cover Type[a]	Total Area Sampled [ha][b]	Number of Individuals Detected			Relative Population Density [Individuals/ha][c]		
			Boreal Owl	Great Gray Owl	Great Horned Owl	Boreal Owl	Great Gray Owl	Great Horned Owl
Other								
BUu	burned upland	3,433	3	-	-	0.001	-	-
BUw	burned wetland	1,023	2	-	-	0.002	-	-
CC	clearcut	84	-	-	-	-	-	-
DIS	disturbed	1,226	1	2	-	0.001	0.002	-
Lake	lake	387	2	-	-	0.005	-	-
Me	meadow	984	-	-	-	-	-	-
Sh	shrubland	41	-	-	-	-	-	-
	other subtotal	*7,178*	*8*	*2*	*-*	*n/a*	*n/a*	*n/a*
Total		**20,348**	**22**	**3**	**16**	**n/a**	**n/a**	**n/a**

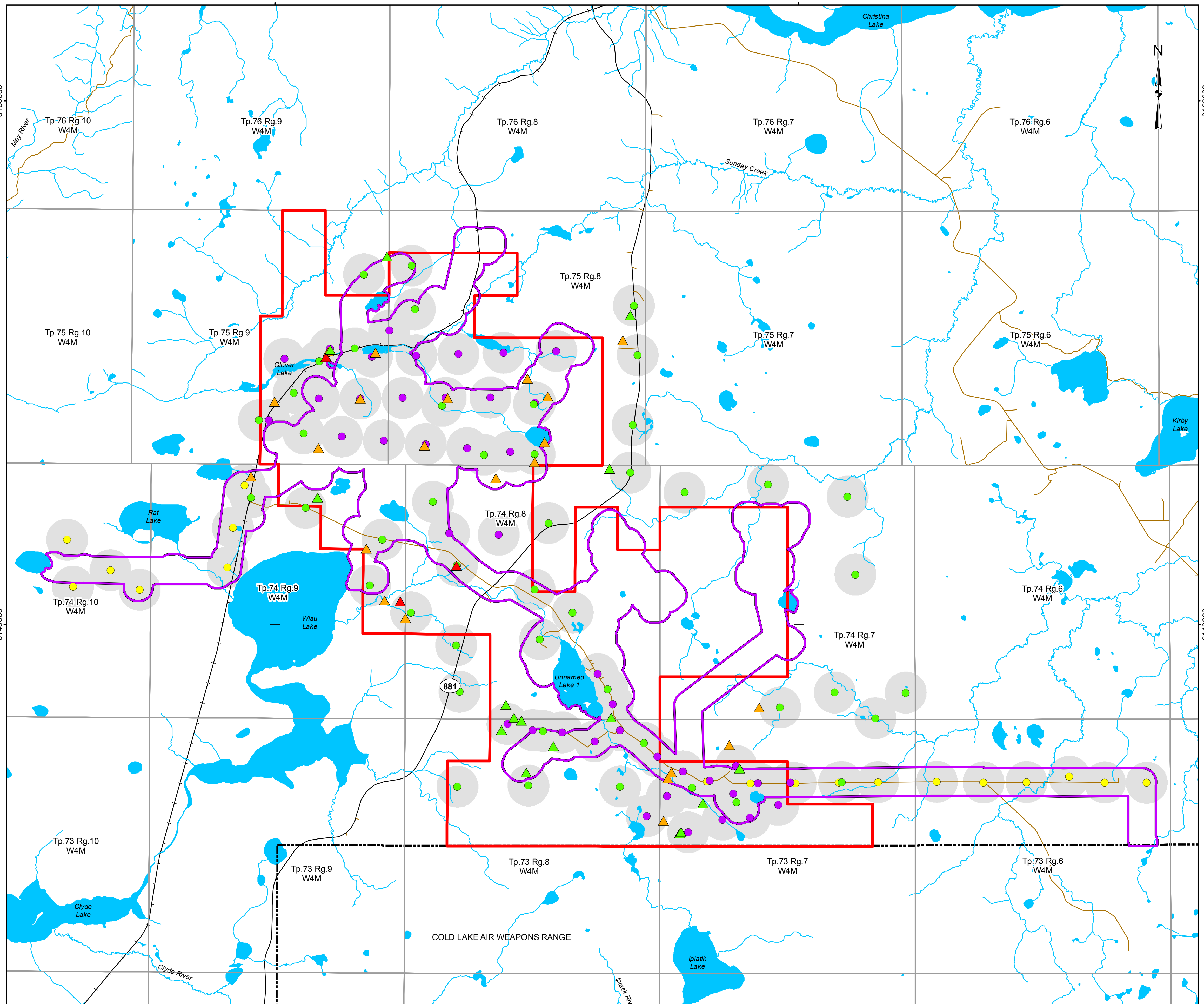
(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within an 800-m listening radius of the plot centre, discounting for some effort overlap within survey years.

(c) Relative population density is calculated by dividing the number of individuals observed by the total area of a land cover sampled.

- = No observations recorded.

n/a = Not applicable.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- 800 m BUFFER OF OWL PLOT
- OWL PLOT LOCATION (2012)
- OWL PLOT LOCATIONS (2011)
- OWL PLOT LOCATIONS (PRE-2011)

SPECIES OBSERVATIONS

- BOREAL OWL
- GREAT GRAY OWL
- GREAT HORNED OWL

NOTE

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PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
OWL SURVEY LOCATIONS AND OBSERVATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2011 AND 2012

Golder Associates

PROJECT		10-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	FIGURE: 10	
REVIEW	JV	11 Dec. 2012		

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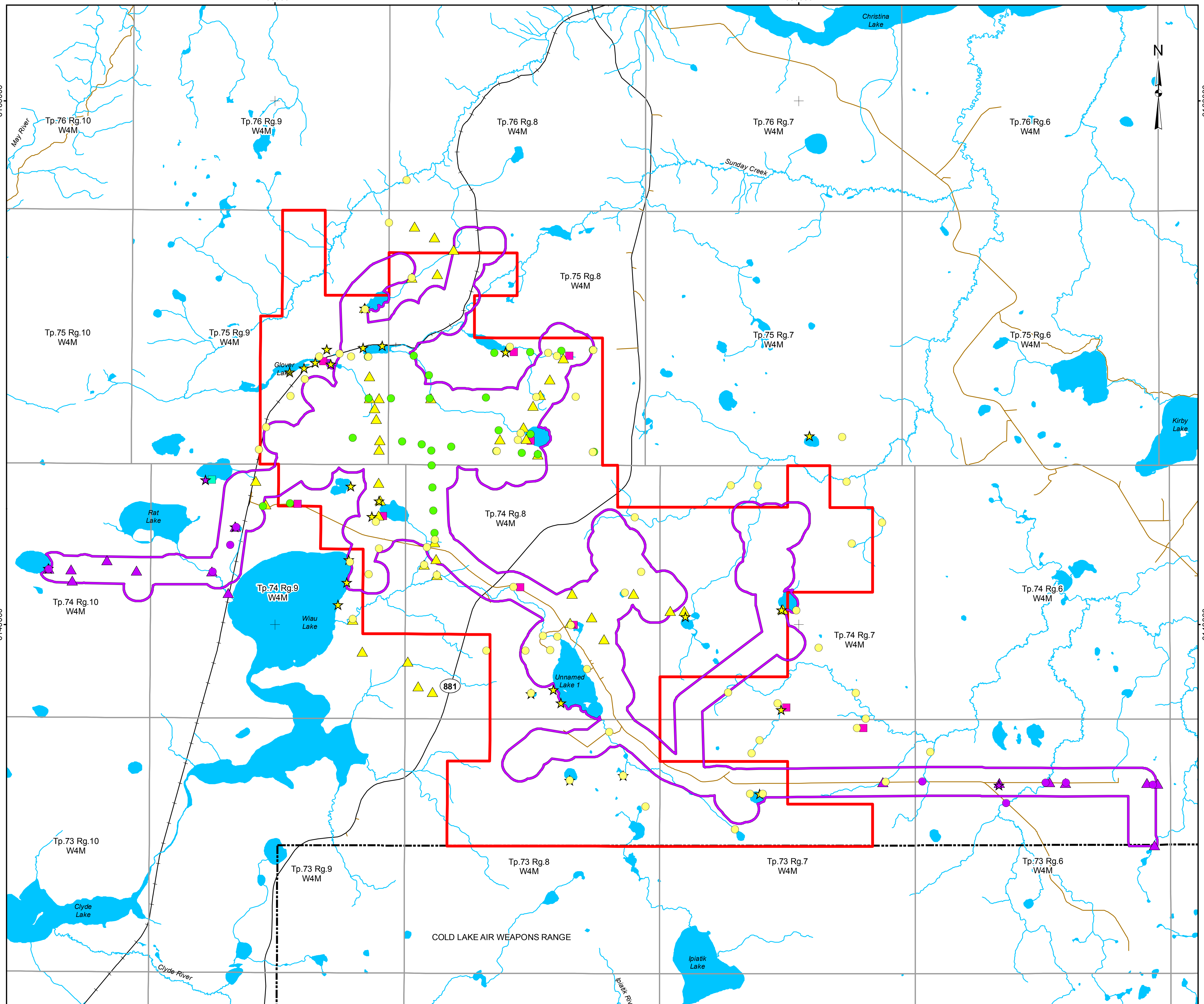
3.4 MARSH BIRD SURVEYS

A total of 104 plots were sampled during marsh bird surveys conducted in and around the LSA from 2008 through 2012 (Table 1, Figure 11). Twenty-five different land cover types were sampled, including nine ecosite phases, nine wetlands types and seven other land cover types. Considering a 200-m listening radius around the plot centre and discounting for some effort overlap within survey years, this equates to 1,293 ha (Table 8).

Eighteen soras were detected during these surveys (Table 8). Soras were recorded in five land cover types, with the majority detected in wetlands (Table 8). No soras were recorded in ecosite phases. Relative sora density (number of individuals detected/ha of area sampled) was highest in the shallow open water (WONN) wetlands type. No pied-billed grebes, American bitterns or Virginia rails were detected during the surveys; however, one pied-billed grebe was recorded incidentally. The 2011 Wildlife Baseline Report (Canadian Natural 2011) erroneously included three incidental observations in the marsh bird results (two soras and one pied-billed grebe). After excluding these records, the number of survey observations reported for these two species has decreased from 2011.Soras are the most commonly detected marsh bird in the Oil Sands Region and have been recorded in a variety of wetlands types within the RSA (e.g., EnCana 2009; Attachment E, Table E-28). Pied-billed grebes and American bitterns are infrequently detected, and Virginia rails have not been detected during marsh bird surveys in the RSA (Attachment E, Table E-28).



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

PLOT LOCATIONS

- HORNED GREBE (2012)
- HORNED GREBE (2011)
- MARSH BIRD (2012)
- MARSH BIRD (2011)
- MARSH BIRD (PRE-2011)
- YELLOW RAIL (2012)
- YELLOW RAIL (2011)

SPECIES OBSERVATIONS

- HORNED GREBE
- SORA

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), AND FROM IHS ENERGY INC. ALBERTA VEGETATION INVENTORY OBTAINED FROM ALBERTA PACIFIC LTD. (2007, 2011).
DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

MARSH BIRD, YELLOW RAIL AND HORNED GREBE SURVEY LOCATIONS AND OBSERVATIONS IN AND AROUND THE LOCAL STUDY AREA, 2008, 2011 AND 2012

Golder Associates

PROJECT	12-1346-0014		FILE No.
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN REV. 0
GIS	GU	21 Nov. 2012	
CHECK	JG	11 Dec. 2012	**FIGURE: 11**
REVIEW	JV	11 Dec. 2012	

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Table 8 Marsh Bird Survey Sampling Effort and Observation in and Around the Local Study Area, 2008, 2011 and 2012

Map Code	Land Cover Type[(a)]	Total Area Sampled[(b)] [ha]	Number of Sora Detected	Relative Sora Population Density [Individuals/ha][(b)]
Ecosite Phase				
a1	lichen jack pine	25	-	-
b1	blueberry jackpine-aspen	20	-	-
b3	blueberry aspen-white spruce	1	-	-
b4	blueberry white spruce-jack pine	1	-	-
c1	Labrador tea–mesic jack pine-black spruce	75	-	-
d1	low-bush cranberry aspen	17	-	-
d2	low-bush cranberry aspen-white spruce	6	-	-
e2	dogwood balsam poplar-white spruce	6	-	-
g1	Labrador tea–subhygric black spruce-jack pine	35	-	-
	ecosite subtotal	*186*	*0*	*n/a*
Wetlands Type				
BTNN	wooded bog	55	-	-
FONG	graminoid fen	127	4	0.03
FONS	shrubby fen	215	4	0.02
FTNI	wooded fen with internal lawns	<1	-	-
FTNN	wooded fen	157	-	-
MONG	graminoid marsh	10	-	-
SONS	shrubby swamp	27	-	-
STNN	wooded swamp	18	-	-
WONN	shallow open water	16	4	0.25
	wetlands subtotal	*627*	*12*	*n/a*
Other				
BUu	burned upland	224	-	-
BUw	burned wetlands	64	-	-
CC	clearcut	2	-	-
DIS	disturbed	86	3	0.04
Lake	lake	76	3	0.04
Me	meadow	29	-	-
Sh	shrubland	<1	-	-
	other subtotal	*481*	*6*	*n/a*
Total[(c)]		**1,293**	**18**	**n/a**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within a 200-m listening radius of the plot centre, discounting for some effort overlap within survey years.

(c) Relative population density is calculated by dividing the number of individuals observed by the total area of a land cover sampled.

- = No observations recorded.

n/a = Not applicable.

3.5 YELLOW RAIL SURVEYS

A total of 59 plots were sampled in 24 different land cover types during yellow rail surveys conducted in and around the LSA in 2011 and 2012 (Tables 1 and 9, Figure 11). Considering a 200-m listening radius around the plot centre; this equates to 741 ha (Table 9). Of the total area surveyed for yellow rails, 200 ha occurred in shrubby fen (FONS) and 106 ha in graminoid fen (FONG) wetlands types (Table 9). These two wetlands types are similar to the general breeding habitat described for yellow rails (Goldade et al. 2002). Yellow rails were not detected during these surveys, nor were any recorded incidentally during other field surveys conducted for the Project.

Data from other projects in the RSA are not available because yellow rail-specific surveys are a recent addition to survey protocols in the Oil Sands Region. To date, yellow rail surveys have primarily been conducted north of Fort McMurray (Attachment E, Table E-40). Since these surveys were initiated, 64 yellow rails have been recorded within five different study areas from 2008 through 2012 (Attachment E, Table E-40). Of the yellow rails detected, 34 were recorded in shrubby fen (FONS) and 30 in graminoid fen (FONG) wetlands types (Attachment E, Table E-40). Before yellow rail surveys were implemented in the Oil Sands Region, the species was very rarely detected during general marsh bird surveys or incidentally (Attachment E, Table E-39).

3.6 HORNED GREBE SURVEYS

A total of 29 plots were sampled during horned grebe surveys conducted in and around the LSA in 2011 and 2012 (Table 1, Figure 11). Three land cover types were sampled: graminoid fen (FONG), shallow open water (WONN) and lakes (Table 10). These land cover types are similar to the general breeding habitat described for horned grebes (Stedman 2000). Based on search area dimensions estimated at the time of the surveys; this equates to 556 ha (Table 10). Two horned grebes were detected in a lake, resulting in a relative density (number of individuals detected/ha of area sampled) of less than 0.1 (Table 10).

The ability to make comparisons to other projects in the RSA is limited since horned grebe surveys are a very recent addition to survey protocols in the Oil Sands Region (Attachment E, Table E-41).

Table 9 Yellow Rail Survey Sampling Effort in and Around the Local Study Area, 2011 and 2012

Map Code	Land Cover Type[a]	Total Area Sampled [ha][b]
Ecosite Phase		
a1	lichen jack pine	16
b1	blueberry jackpine-aspen	2
b3	blueberry aspen-white spruce	1
b4	blueberry white spruce-jack pine	1
c1	Labrador tea–mesic jack pine-black spruce	42
d1	low-bush cranberry aspen	6
d2	low-bush cranberry aspen-white spruce	2
e1	dogwood balsam poplar-aspen	1
e2	dogwood balsam poplar-white spruce	<1
g1	Labrador tea–subhygric black spruce-jack pine	14
	ecosite subtotal	*85*
Wetlands Type		
BTNN	wooded bog	25
FONG	graminoid fen	106
FONS	shrubby fen	200
FTNI	wooded fen with internal lawns	6
FTNN	wooded fen	94
MONG	graminoid marsh	5
SONS	shrubby swamp	3
STNN	wooded swamp	1
WONN	shallow open water	2
	wetlands subtotal	*443*
Other		
BUu	burned upland	83
BUw	burned wetland	53
DIS	disturbed	48
Lake	lake	18
Me	meadow	7
ND	no data[c]	5
	other subtotal	*213*
Total		**741**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within a 200-m listening radius of the plot centre.

(c) A portion of the survey effort was outside the extent of available vegetation mapping.

Table 10 Horned Grebe Survey Sampling Effort and Observations in and Around the Local Study Area, 2011 and 2012

Map Code	Land Cover Type[(a)]	Total Area Sampled[(b)] [ha]	Number of Plots	Number of Observations	Mean Relative Abundance (±SD)	Relative Abundance Confidence Interval (95%)	Mean Relative Density (±SD)	Relative Density Confidence Interval (95%)
Wetlands Type								
FONG	graminoid fen	27	3	-	0.0±0.0	n/a	0.0±0.0	n/a
WONN	shallow open water	98	7	-	0.0±0.0	n/a	0.0±0.0	n/a
	wetlands subtotal	*125*	*10*	*0*	*n/a*	*n/a*	*n/a*	*n/a*
Other								
Lake	lake	431	19	2	0.1±0.5	(0.0,0.3)	<0.1±<0.1	(0.0,<0.1)
	other subtotal	*431*	*19*	*2*	*n/a*	*n/a*	*n/a*	*n/a*
Total		**556**	**29**	**2**	**n/a**	**n/a**	**n/a**	**n/a**

(a) Halsey et al. (2003).

(b) Based on search area dimensions estimated at time of survey.

- = No observations recorded.

n/a = Not applicable.

Note: SD = Standard deviation; zeros are reported due to lack of data at sample points.

3.7 BREEDING SONGBIRD SURVEYS

From 2001 to 2012, 364 breeding songbird point counts were completed in 12 ecosite phases, eight wetlands types and six other land cover types in and around the LSA (Tables 1 and 11, Figures 12 and 13). Breeding songbird survey plots were placed to be representative of the proportional distribution of land cover types in and around the LSA, while also taking care to represent a wide range of land cover types and land cover types where federally listed species are more likely to be found.

Of the 364 points counts conducted during breeding songbird surveys, 119 focused on land cover types suitable for federally listed species. Thirty-seven plots targeted Canada warbler, 32 plots targeted olive-sided flycatcher, 25 plots targeted rusty blackbird, and an additional 25 plots targeted both olive-sided flycatcher and rusty blackbird due to their overlapping use of some shrubby and wooded wetlands types (Table 12).

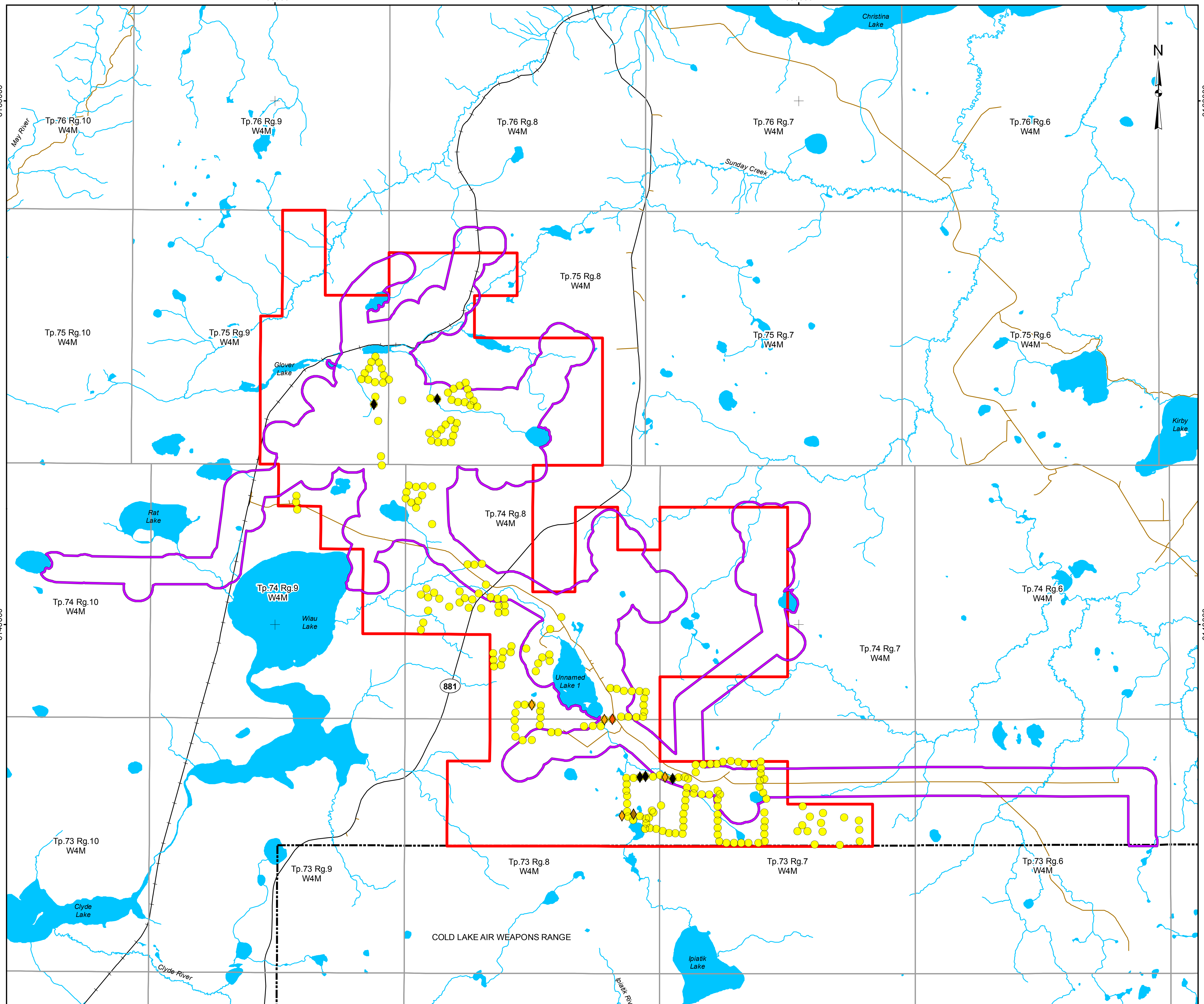
Table 11 Breeding Songbird Point Count Land Cover Types in and Around the Local Study Area, 2001, 2008, 2009, 2011 and 2012

Map Code	Land Cover Type[(a)]	Sample Plots		
		Number of Plots	% of Total Plots	Area Sampled [ha][(b)]
Ecosite Phase				
a1	lichen jack pine	18	5	14
b1	blueberry jack pine-aspen	12	3	9
b2	blueberry aspen (white birch)	2	1	2
b3	blueberry aspen-white spruce	2	1	2
b4	blueberry white spruce-jack pine	3	1	2
c1	Labrador tea–mesic jack pine-black spruce	34	9	27
d1	low-bush cranberry aspen	33	9	26
d2	low-bush cranberry aspen-white spruce	20	5	16
d3	low-bush cranberry white spruce	3	1	2
e3	dogwood white spruce	1	<1	1
g1	Labrador tea–subhygric black spruce-jack pine	33	9	26
h1	Labrador tea/horesetail white spruce-black spruce	1	<1	1
	ecosite subtotal	*162*	*45*	*127*
Wetlands Type				
BTNN	wooded bog	27	7	21
FONG	graminoid fen	6	2	5
FONS	shrubby fen	37	10	29
FTNN	wooded fen	58	16	46
MONG	graminoid marsh	1	<1	1
SONS	shrubby swamp	17	5	13
STNN	wooded swamp	2	1	2
WONN	open water	2	1	2
	wetlands subtotal	*150*	*41*	*118*
Other				
BUu	burned upland	21	6	16
BUw	burned wetlands	10	3	8
CC	clearcut	2	1	2
DIS	disturbed	2	1	2
Riparian	riparian	1	<1	1
Sh	shrubland	16	4	13
	other subtotal	*52*	*14*	*41*
Total		**364**	**100**	**286**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within a 50-m radius of the plot centre.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



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LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- BREEDING SONGBIRD PLOT LOCATION

SPECIES OBSERVATIONS

- COMMON YELLOWTHROAT
- OLIVE-SIDED FLYCATCHER
- WESTERN TANAGER
- WESTERN WOOD-PEWEE

NOTE

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ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

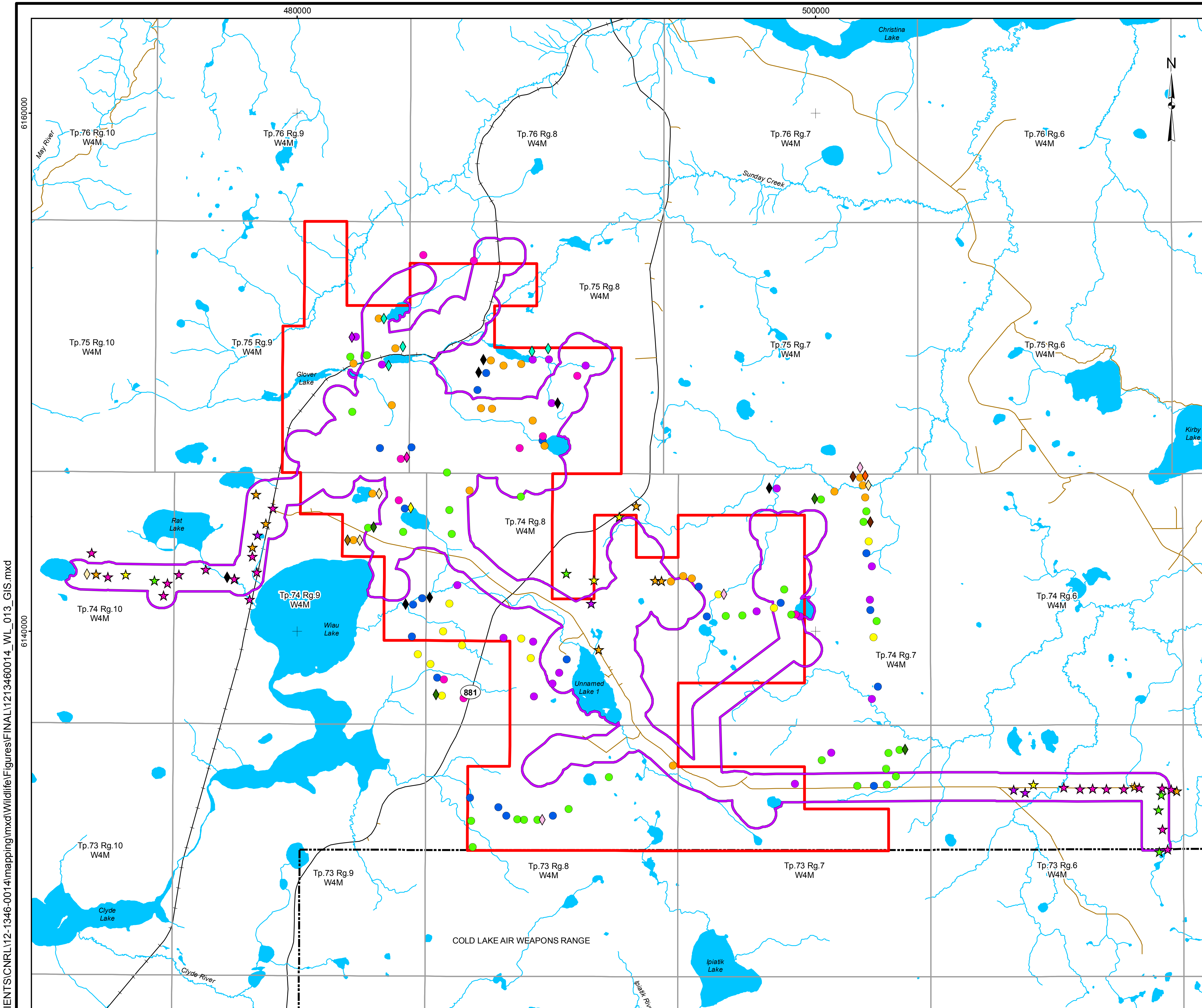
5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
BREEDING SONGBIRD POINT COUNT LOCATIONS AND OBSERVATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008 AND 2009

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	**FIGURE: 12**	
REVIEW	JV	11 Dec. 2012		



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

SPECIES PLOT LOCATIONS (2011)

- CANADA WARBLER
- COMMON NIGHTHAWK
- GENERAL BREEDING SONGBIRD
- OLIVE-SIDED FLYCATCHER
- OLIVE-SIDED FLYCATCHER/RUSTY BLACKBIRD
- RUSTY BLACKBIRD

SPECIES PLOT LOCATIONS (2012)

- CANADA WARBLER
- COMMON NIGHTHAWK
- GENERAL BREEDING SONGBIRD
- OLIVE-SIDED FLYCATCHER
- OLIVE-SIDED FLYCATCHER/RUSTY BLACKBIRD
- RUSTY BLACKBIRD

SPECIES OBSERVATIONS

- BAY-BREASTED WARBLER
- BROWN CREEPER
- CAPE MAY WARBLER
- COMMON NIGHTHAWK
- COMMON YELLOWTHROAT
- LEAST FLYCATCHER
- OLIVE-SIDED FLYCATCHER
- SEDGE WREN
- RUSTY BLACKBIRD
- WESTERN TANAGER
- WESTERN WOOD-PEWEE

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

BREEDING SONGBIRD AND COMMON NIGHTHAWK POINT COUNT LOCATIONS AND OBSERVATIONS IN AND AROUND THE LOCAL STUDY AREA, 2011 AND 2012

Golder Associates

PROJECT	12-1346-0014	FILE No.
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012		
REVIEW	JV	11 Dec. 2012		

FIGURE: 13

Table 12 Breeding Songbird Species at Risk Point Count Land Cover Types in and Around the Local Study Area, 2011 and 2012

Map Code	Land Cover Type[(a)]	Sample Plots		
		Number of Plots	% of Total Plots	Area Sampled [ha][(b)]
Canada Warbler Survey				
b1	blueberry jackpine-aspen	5	4	4
b2	blueberry aspen (white birch)	2	2	2
d1	low-bush cranberry aspen	22	18	17
d2	low-bush cranberry aspen-white spruce	8	7	6
	Canada warbler subtotal	*37*	*31*	*29*
Olive-sided Flycatcher Survey				
b1[(c)]	blueberry jack pine-aspen	1	1	1
BUu	burned upland	18	15	14
BUw	burned wetlands	7	6	5
d3[(c)]	low-bush cranberry white spruce	3	3	2
g1[(c)]	Labrador tea-subhygric black spruce-jack pine	3	3	2
	olive-sided flycatcher subtotal	*32*	*27*	*25*
Rusty Blackbird Survey				
BTNN	wooded bog	8	7	6
FONG	graminoid fen	5	4	4
FTNN	wooded fen	2	2	2
g1[(d)]	Labrador tea–subhygric black spruce-jack pine	2	2	2
SONS	shrubby swamp	8	7	6
	rusty blackbird subtotal	*25*	*21*	*20*
Olive-sided Flycatcher and Rusty Blackbird Survey				
FONS	shrubby fen	8	7	6
FTNN	wooded fen	16	13	13
STNN	wooded swamp	1	1	1
	olive-sided flycatcher and rusty blackbird subtotal	*25*	*21*	*20*
Total		**119**	**100**	**93**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within a 50-m radius of the plot centre.

(c) Mature coniferous forest near the edge of an open area (i.e., burns, clearcuts, meadows, lakes or shrubland); suitable for olive-sided flycatcher.

(d) Low-lying hygric to subhygric (high soil water content) forest near forested or shrubby wetlands or swamps; suitable for rusty blackbird.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.7.1 Species Present

Fifty-three songbird species and 861 individual songbirds were recorded during breeding songbird point counts in and around the LSA (Table 13). Five of the most commonly observed species comprised 50% of all observations. Yellow-rumped warbler was the most commonly detected species, followed by (in order of decreasing detection frequency) chipping sparrow, dark-eyed junco, alder flycatcher and Tennessee warbler.

Table 13 Breeding Songbird Detections in and Around the Local Study Area, 2001, 2008, 2009, 2011 and 2012

Species	Total Number of Observations	Number of Land Cover Types With Species	Provincial Status[(a)]	Federal Status[(b)]
yellow-rumped warbler	150	14	Secure	n/a
chipping sparrow	94	15	Secure	n/a
dark-eyed junco	66	12	Secure	n/a
alder flycatcher	62	12	Secure	n/a
Tennessee Warbler	56	16	Secure	n/a
palm warbler	55	8	Secure	n/a
ruby-crowned kinglet	49	7	Secure	n/a
Lincoln's sparrow	29	7	Secure	n/a
hermit thrush	24	9	Secure	n/a
ovenbird	19	4	Secure	n/a
white-throated sparrow	18	7	Secure	n/a
red-eyed vireo	17	6	Secure	n/a
Swainson's thrush	17	8	Secure	n/a
common yellowthroat	16	5	Sensitive	n/a
clay-coloured sparrow	14	8	Secure	n/a
Le Conte's sparrow	14	7	Secure	n/a
orange-crowned warbler	12	6	Secure	n/a
boreal chickadee	9	5	Secure	n/a
cedar waxwing	9	4	Secure	n/a
swamp sparrow	9	4	Secure	n/a
tree swallow	9	5	Secure	n/a
olive-sided flycatcher	8	7	May Be At Risk[(c)]	Threatened
least flycatcher	7	2	Sensitive	n/a
magnolia warbler	7	5	Secure	n/a
red-breasted nuthatch	7	6	Secure	n/a
white-winged crossbill	7	4	Secure	n/a
winter wren	7	6	Secure	n/a
mourning warbler	6	3	Secure	n/a
American redstart	5	5	Secure	n/a
golden-crowned kinglet	5	5	Secure	n/a
yellow-bellied sapsucker	5	2	Secure	n/a
black-capped chickadee	4	2	Secure	n/a
brown creeper	4	3	Sensitive	n/a
red-winged blackbird	4	2	Secure	n/a
American robin	3	2	Secure	n/a
bay-breasted warbler	3	3	Sensitive	n/a
black-and-white warbler	3	3	Secure	n/a
Nashville warbler	3	3	Secure	n/a
Wilson's warbler	3	2	Secure	n/a
Cape May warbler	2	2	Sensitive	n/a
Connecticut warbler	2	2	Secure	n/a
eastern kingbird	2	2	Secure	n/a
Philadelphia vireo	2	2	Secure	n/a
song sparrow	2	1	Secure	n/a
western tanager	2	2	Sensitive	n/a
western wood-pewee	2	2	Sensitive	n/a
yellow-bellied flycatcher	2	2	Undetermined[(d)]	n/a
blackpoll warbler	1	1	Secure	n/a
blue-headed vireo	1	1	Secure	n/a

Table 13 Breeding Songbird Detections in and Around the Local Study Area, 2001, 2008, 2009, 2011 and 2012 (continued)

Species	Total Number of Observations	Number of Land Cover Types With Species	Provincial Status[a]	Federal Status[b]
mountain bluebird	1	1	Secure	n/a
rose-breasted grosbeak	1	1	Secure	n/a
rusty blackbird	1	1	Sensitive	Special Concern
sedge wren	1	1	Sensitive[e]	n/a
Total	**861**	**n/a**	**n/a**	**n/a**

[a] ESRD (Environment and Sustainable Resource Development 2011).
[b] Species at Risk Public Registry (2012).
[c] Olive-sided flycatcher was erroneously reported as sensitive in Table 19 of the 2011 Wildlife Baseline Report (Canadian Natural 2011).
[d] Yellow-bellied flycatcher was erroneously reported as secure in Table 19 of the 2011 Wildlife Baseline Report (Canadian Natural 2011).
[e] Sedge wren was erroneously reported as secure in Table 19 of the 2011 Wildlife Baseline Report (Canadian Natural 2011).
n/a = Not applicable.

Ten provincially and federally listed songbird species were identified in and around the LSA (Figures 12 and 13). The number observed and habitat used by these ten species is as follows:

- Sixteen common yellowthroats were detected predominantly in fen wetlands types.
- Eight olive-sided flycatchers were detected in conifer ecosite phases, burned upland (BUu), burned wetland (BUw) and several wetlands types.
- Seven least flycatchers were detected in burned upland (BUu) and shrubby swamp (SONS) land cover types. No least flycatchers were recorded in ecosite phases.
- Four brown creepers were detected in conifer, mixedwood and deciduous ecosite phases. No brown creepers were recorded in wetlands types.
- Three bay-breasted warblers were detected in conifer and mixedwood ecosite phases. No bay-breasted warblers were recorded in wetlands types.
- Two Cape May warblers were detected in low-bush cranberry aspen-white spruce (d2) and low-bush cranberry white spruce (d3) ecosite phases.
- Two western wood-pewees were detected in low-bush cranberry white spruce (d3) and open water (WONN) land cover types.
- Two western tanagers were detected in lichen jack pine (a1) and low-bush cranberry white spruce (d3) ecosite phases.
- One rusty blackbird was detected in the graminoid fen (FONG) wetlands type.

- One sedge wren was detected in the shrubby fen (FONS) wetlands type.

3.7.2 Relative Abundance and Distribution

The yellow-rumped warbler, the most abundant species (150 observations), was detected in approximately one third of the point counts sampled and over half the land cover types sampled (Table 13). This species was detected predominantly in upland conifer such as the Labrador tea–mesic jack pine-black spruce (c1) and Labrador tea–subhygric black spruce-jack pine (g1) ecosite phases and in wooded fen (FTNN), wooded bog (BTNN) and shrubby fen (FONS) wetlands types. Some species were fairly abundant, but restricted to relatively few land cover types. For example, 56 palm warblers were recorded in only eight land cover types, predominantly in shrubby fen (FONS) and wooded fen (FTNN) wetlands types.

Twenty-eight species occurred in four or more of the land cover types surveyed in and around the LSA (Table 13). Eighteen species occurred in two or three land cover types, while seven species occurred in only one land cover type. The Tennessee warbler was the most widespread species; it was observed in 16 of the 26 land cover types sampled, followed by the chipping sparrow and yellow-rumped warbler, which were detected in 15 and 14 of the land cover types sampled, respectively.

For land cover types with three or more plots, mean relative abundance (i.e., detections per plot) of breeding songbirds was greatest in the low-bush cranberry white spruce (d3) ecosite phase, followed by shrubby swamp (SONS) and wooded bog (BTNN) land cover types (Table 14). Mean relative abundance was lowest in the graminoid fen (FONG) wetlands type, followed by lichen jack pine (a1) and blueberry jack pine-aspen (b1) ecosite phases (Table 14).

During targeted songbird species at risk surveys in and around the LSA, no Canada warblers, four olive-sided flycatchers and one rusty blackbird were detected. The four olive-sided flycatchers were recorded in four different plots (Table 15 and Figure 13), which account for 13% of the plots surveyed for olive-sided flycatchers. Observations occurred in burned upland (BUu), burned wetland (BUw) and low-bush cranberry white spruce (d3) land cover types. The rusty blackbird was recorded within a graminoid fen (FONG) wetlands type, representing 2% of the plots surveyed for rusty blackbirds (Table 15). An additional four olive-sided flycatchers were detected during general breeding songbird surveys in 2001, 2008 and 2009, in shrubby swamp (SONS), shallow open water (WONN), shrubby fen (FONS) and Labrador tea–mesic jack pine-black spruce (c1) land cover types. These surveys occurred prior to implementation of targeted survey protocols.

Table 14 Breeding Songbird Species Abundance, Richness and Diversity by Land Cover Type in and Around the Local Study Area, 2001, 2008, 2009, 2011 and 2012

Map Code	Land Cover Type[a]	Number of Plots	Mean Relative Abundance (±SD)[b]	Mean Richness (±SD)[b]	Mean Diversity (±SD)[b,c]
Ecosite Phase					
a1	lichen jack pine	18	1.2±1.1	1.2±1.0	0.3±0.4
b1	blueberry jackpine-aspen	12	1.3±0.9	1.3±0.9	0.3±0.4
b2	blueberry aspen (white birch)	2	2.0	1.5	0.5
b3	blueberry aspen-white spruce	2	2.5	2.5	0.9
b4	blueberry white spruce-jack pine	3	1.7±1.5	1.0±1.0	0.4±0.4
c1	Labrador tea–mesic jack pine-black spruce	34	2.3±1.3	1.9±1.1	0.6±0.5
d1	low-bush cranberry aspen	33	2.0±1.6	1.9±1.5	0.6±0.6
d2	low-bush cranberry aspen-white spruce	20	2.2±1.6	1.9±1.3	0.5±0.5
d3	low-bush cranberry white spruce	3	4.7±2.1	4.0±1.0	1.3±0.2
e3	dogwood white spruce	1	1.0	1.0	0.0
g1	Labrador tea–subhygric black spruce-jack pine	33	2.2±1.6	1.9±1.2	0.5±0.5
h1	Labrador tea/horesetail white spruce-black spruce	1	1.0	1.0	0.0
	ecosite subtotal	*162*	*n/a*	*n/a*	*n/a*
Wetlands Type					
BTNN	wooded bog	27	2.7±1.6	2.3±1.4	0.8±0.5
FONG	graminoid fen	6	0.5±1.2	0.5±1.2	0.2±0.5
FONS	shrubby fen	37	2.5±1.8	2.1±1.6	0.6±0.6
FTNN	wooded fen	58	2.6±1.5	2.2±1.1	0.7±0.5
MONG	graminoid marsh	1	0.0	0.0	0.0
SONS	shrubby swamp	17	4.6±3.5	3.8±2.6	1.1±0.7
STNN	wooded swamp	2	2.5	2.5	0.9
WONN	open water	2	4.5	3.5	1.2
	wetlands subtotal	*150*	*n/a*	*n/a*	*n/a*
Other					
BUu	burned upland	21	2.7±2.4	2.3±1.8	0.7±0.7
BUw	burned wetlands	10	1.9±0.6	1.8±0.4	0.6±0.3
CC	clearcut	2	4.0	3.0	1.1
DIS	disturbed	2	3.0	1.0	0.4
Riparian	riparian	1	3.0	3.0	1.1
Sh	shrubland	16	2.2±1.4	1.9±1.3	0.6±0.5
	other subtotal	*52*	*n/a*	*n/a*	*n/a*
Total		**364**	**n/a**	**n/a**	**n/a**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Standard deviation (SD) reported for land cover types with more than two plots (i.e., point counts). Values reported for land cover types with one plot are not means.

(c) Species diversity was calculated using the Shannon Diversity Index (Krebs 2009).

n/a = Not applicable.

Table 15 Songbird Species at Risk Detections by Land Cover Type in and Around the Local Study Area, 2011 and 2012

Map Code	Land Cover Type[a]	Number of Plots	Number of Observations	Mean Relative Abundance (±SD)[b]	Relative Abundance Confidence Interval (95%)	Mean Relative Density (±SD)[b]	Relative Density Confidence Interval (95%)
Canada Warbler							
b1	blueberry jackpine-aspen	5	-	0.0±0.0	n/a	0.0±0.0	n/a
b2	blueberry aspen (white birch)	2	-	0.0±0.0	n/a	0.0±0.0	n/a
d1	low-bush cranberry aspen	22	-	0.0±0.0	n/a	0.0±0.0	n/a
d2	low-bush cranberry aspen-white spruce	8	-	0.0±0.0	n/a	0.0±0.0	n/a
Total		**37**	**0**	**0.0±0.0**	**n/a**	**0.0±0.0**	**n/a**
Olive-sided Flycatcher							
b1[c]	blueberry jack pine-aspen	1	-	0.0	n/a	0.0	n/a
BUu	burned upland	17	1	0.1±0.3	(0.0,0.3)	0.1±0.4	(0.0,0.3)
BUw	burned wetlands	8	2	0.1±0.4	(0.0,0.4)	0.2±0.5	(0.0,0.5)
d3[c]	low-bush cranberry white spruce	3	1	0.3±0.6	(0.0,1.0)	0.4±0.7	(0.0,1.3)
g1[c]	Labrador tea–subhygric black spruce-jack pine	3	-	0.0±0.0	n/a	0.0±0.0	n/a
FONS	shrubby fen	8	-	0.0±0.0	n/a	0.0±0.0	n/a
FTNN	wooded fen	18	-	0.0±0.0	n/a	0.0±0.0	n/a
STNN	wooded swamp	1	-	0.0	n/a	0.0	n/a
Total		**59**	**4**	**<0.1±0.2**	**(0.0,0.1)**	**<0.1±0.2**	**(0.0,0.1)**
Rusty Blackbird							
BTNN	wooded bog	8	-	0.0±0.0	n/a	0.0±0.0	n/a
FONG	graminoid fen	5	1	0.2±0.5	(0.0,0.6)	0.3±0.6	(0.0,0.8)
FONS	shrubby fen	8	-	0.0±0.0	n/a	0.0±0.0	n/a
FTNN	wooded fen	18	-	0.0±0.0	n/a	0.0±0.0	n/a
g1[d]	Labrador tea–subhygric black spruce-jack pine	2	-	0.0	n/a	0.0	n/a
SONS	shrubby swamp	8	-	0.0±0.0	n/a	0.0±0.0	n/a
STNN	wooded swamp	1	-	0.0	n/a	0.0	n/a
Total		**50**	**1**	**<0.1±0.1**	**(0.0,<0.1)**	**<0.1±0.1**	**(0.0,<0.1)**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Standard deviation (SD) reported for land cover types with more than two plots (i.e., point counts). Values reported for land cover types with one plot are not means.

(c) Mature coniferous forest near the edge of an open area (i.e., burns, clearcuts, meadows, lakes or shrubland); suitable for olive-sided flycatcher.

(d) Low-lying hygric to subhygric (high soil water content) forest near forested or shrubby wetlands or swamps; suitable for rusty blackbird.

- = No observations recorded.

n/a = Not applicable.

Note: The number of plots for olive-sided flycatcher and rusty blackbird include 24 plots where both species were surveyed for simultaneously, and are therefore counted for each species. Total relative abundance, relative density and confidence interval per species represent overall measures for all land cover types combined.

3.7.3 Species Richness

For land cover types with three or more plots, mean species richness was greatest in the low-bush cranberry white spruce (d3) ecosite phase, followed by shrubby swamp (SONS) and wooded bog (BTNN) land cover types (Table 14). Mean species richness was lowest in the graminoid fen (FONG) wetlands type, followed by blueberry white spruce-jack pine (b4) and lichen jack pine (a1) ecosite phases (Table 14).

3.7.4 Species Diversity

For land cover types with three or more plots, mean species diversity was greatest in the low-bush cranberry white spruce (d3) ecosite phase, followed by shrubby swamp (SONS) and wooded bog (BTNN) land cover types (Table 14). Mean species diversity was lowest in the graminoid fen (FONG) wetlands type, followed by lichen jack pine (a1) and blueberry jack pine-aspen (b1) ecosite phases (Table 14).

3.7.5 Regional Comparison

Based on regional meta-analysis results, species composition in and around the LSA appears to be representative of the Oil Sands Region in regards to the most commonly detected species. All species found in the LSA have been observed elsewhere in the Oil Sands Region (Attachment F, Table F-1).

Compared to the LSA, relative abundance is markedly lower in the wooded bog (BTNN) wetlands type in the Oil Sands Region. Land cover types with highest and lowest average relative abundance, richness and diversity are otherwise similar between the LSA and the Oil Sands Region (Attachment E, Table E-42). Overall, average relative abundance, species richness, and species diversity values reported for land cover types sampled in and around the LSA are similar to, though usually slightly lower than, values reported for land cover types sampled across the Oil Sands Region (Table 14; Attachment F, Table F-2). Slightly lower values in and around the LSA are likely due to lower sample sizes (364 point counts) compared to the Oil Sands Region (2,162 point counts) (Table 14; Attachment F, Table F-2).

3.8 COMMON NIGHTHAWK SURVEYS

A total of 31 plots were sampled during common nighthawk surveys conducted in and around the LSA in 2011 and 2012 (Table 1, Figure 13). Point counts were completed in two ecosite phases, four wetlands types and four other land cover types (Table 16). Considering a 100-m listening radius around the plot centre, this equates to 97 ha (Table 16). One common nighthawk was recorded in a shrubby fen (FONS) wetlands type, resulting in a relative density (number of individuals detected/ha of area sampled) of less than 0.1 (Table 16). Nighthawk 'booming' was recorded during this observation.

Table 16 Common Nighthawk Survey Sampling Effort and Observations in and Around the Local Study Area, 2011 and 2012

Map Code	Land Cover Type[(a)]	Area Sampled [ha][(b)]	Number of Plots	Number of Observations	Mean Relative Abundance (±SD)[(c)]	Relative Abundance Confidence Interval (95%)	Mean Relative Density (±SD)[(c)]	Relative Density Confidence Interval (95%)
Ecosite Phase								
d2	low-bush cranberry aspen-white spruce	3	1	-	0.0	n/a	0.0	n/a
g1	Labrador tea–subhygric black spruce-jack pine	13	4	-	0.0±0.0	n/a	0.0±0.0	n/a
	ecosite subtotal	*16*	*5*	*0*	*n/a*	*n/a*	*n/a*	*n/a*
Wetlands Type								
BTNN	wooded bog	3	1	-	0.0	n/a	0.0	n/a
FONG	graminoid fen	13	4	-	0.0±0.0	n/a	0.0±0.0	n/a
FONS	shrubby fen	31	10	1	0.1±0.3	(0.0, 0.3)	<0.1±0.1	(0.0, 0.1)
WONN	shallow open water	3	1	-	0.0	n/a	0.0	n/a
	wetlands subtotal	*50*	*16*	*1*	*n/a*	*n/a*	*n/a*	*n/a*
Other								
BUu	burned upland	6	2	-	0.0	n/a	0.0	n/a
BUw	burned wetland	3	1	-	0.0	n/a	0.0	n/a
CC	clearcut	113	4	-	0.0±0.0	n/a	0.0±0.0	n/a
DIS	disturbed	19	3	-	0.0±0.0	n/a	0.0±0.0	n/a
	other subtotal	*31*	*10*	*0*	*n/a*	*n/a*	*n/a*	*n/a*
Total		**97**	**31**	**1**	**n/a**	**n/a**	**n/a**	**n/a**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of habitat sampled within a 100-m radius of the plot centre.

(c) Standard deviation (SD) reported for land cover types with more than two plots (i.e., point counts). Values reported for land cover types with one plot are not means.

- = No observations recorded.

n/a = Not applicable.

The ability to make comparisons to other projects in the RSA is limited since common nighthawk surveys are a very recent addition to survey protocols in the Oil Sands Region (Attachment E, Table E-43).

3.9 AMPHIBIAN SURVEYS

A total of 173 plots were sampled during amphibian surveys conducted in and around the LSA from 2001 to 2012 (Table 1, Figure 14). Thirty land cover types were sampled, including 13 ecosite phases, 10 wetlands types and 7 other land cover types (Table 17). Considering a 250-m listening radius around the plot centre and discounting for some effort overlap within survey years, this equates to 3,192 ha (Table 17).

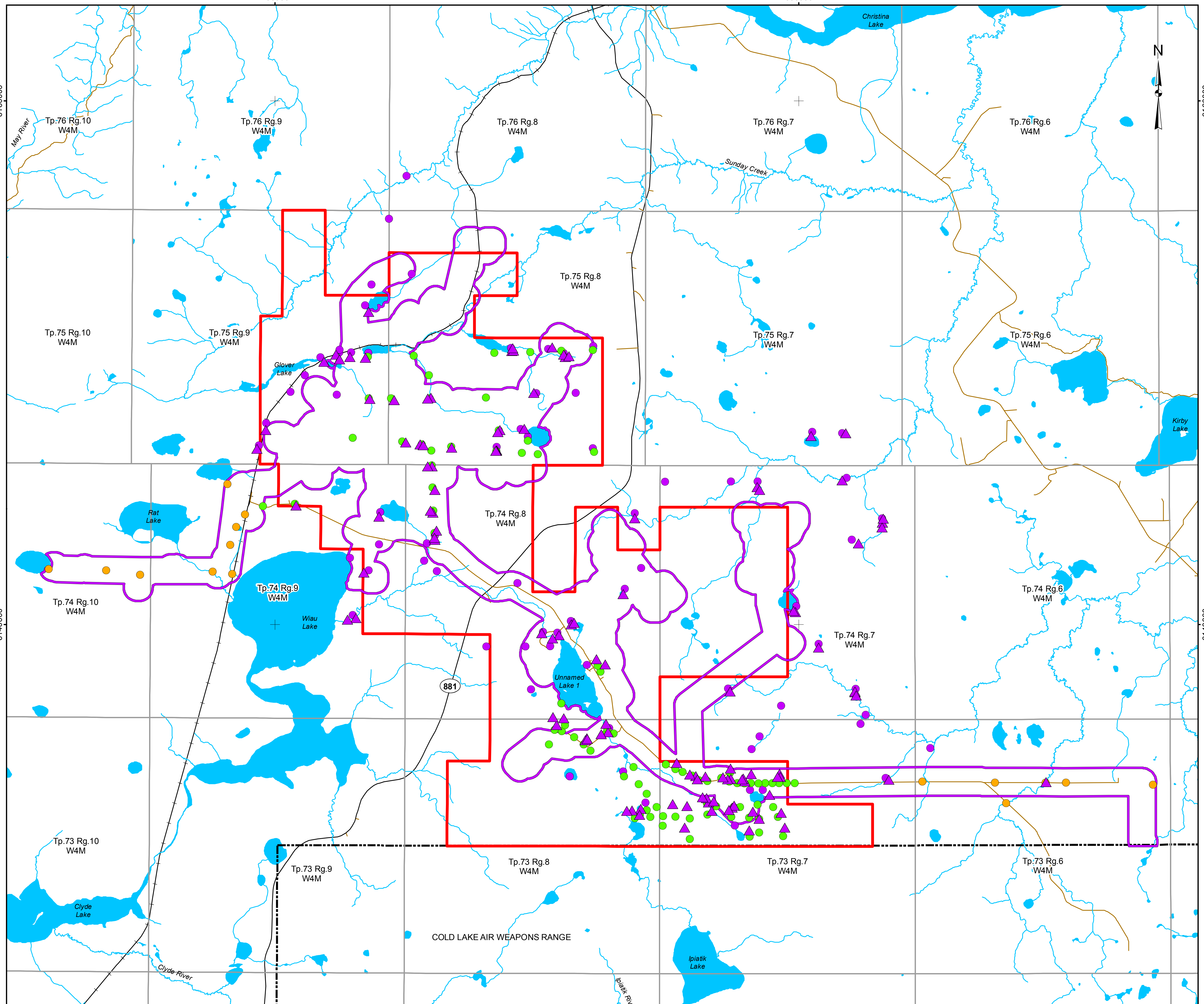
3.9.1 Breeding Evidence

Survey locations were visually inspected for evidence of breeding (e.g., egg clusters, egg strings and tadpoles) at 63 plots in and around the LSA during surveys in 2008, 2011 and 2012. Egg clusters were detected at 11 plots; three clusters were identified as wood frog, one as western toad and seven as an unidentified frog species. Three tadpole groups were observed; two were an unidentified toad species and one an unidentified frog species. The three wood frog egg clusters were detected in standing water within a wooded bog (BTNN) and the western toad egg cluster was observed in a creek less than 5 m across.

3.9.2 Relative Abundance

Of the three amphibian species detected in and around the LSA, boreal chorus frogs were the most numerous (69% of detections), followed by wood frogs (24% of detections) (Table 18). A call index rank of 3 was assumed to equal 30 boreal chorus frogs, 59 wood frogs (Stevens and Paszkowski 2004) and 8 western toads. Estimates of abundance are less reliable for boreal chorus frogs and wood frogs because these data include several rank 3 abundances on the call index scale and it is not possible to determine whether these large choruses are composed of 20- or 100-plus individuals.

The low numbers of boreal chorus and wood frogs recorded during the 2008, 2011 and 2012 surveys relative to the 2001 surveys (Table 18) may reflect declining populations, an unusually cool spring, or other environmental influences. Alternatively, the lower numbers may reflect the fact that surveys in 2008, 2011 and 2012 were conducted later than in 2001 to capture the peak breeding period of toads. The peak toad breeding period ranges from mid-May to early July depending on weather conditions (ACA and ASRD 2006). Since wood frogs and boreal chorus frogs may begin breeding as early as April (ACA and ASRD 2006), the peak breeding period of these two frog species may have been missed during the 2008, 2011 and 2012 surveys.



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA
- AMPHIBIAN PLOT LOCATION (2012)
- AMPHIBIAN PLOT LOCATION (2011)
- AMPHIBIAN PLOT LOCATION (PRE-2011)

SPECIES OBSERVATIONS

- WESTERN TOAD

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2004-2011 (ALL RIGHTS RESERVED), AND FROM IHS ENERGY INC. ALBERTA VEGETATION INVENTORY OBTAINED FROM ALBERTA PACIFIC LTD. (2007, 2011).
DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

AMPHIBIAN SURVEY LOCATIONS AND WESTERN TOAD OBSERVATIONS IN AND AROUND THE LOCAL STUDY AREA, 2001, 2008, 2011 AND 2012

Golder Associates

PROJECT	12-1346-0014		FILE No.	
DESIGN	BS	12 Oct. 2011	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	**FIGURE: 14**	
REVIEW	JV	11 Dec. 2012		

I:\CLIENTS\CNRL\12-1346-0014\mapping\mxd\Wildlife\Figures\FINAL\1213460014_WL_014_GIS.mxd

Table 17 Amphibian Survey Sampling Effort and Estimated Population Densities in and Around the Local Study Area, 2001, 2008, 2011 and 2012

Map Code	Land Cover Type[(a)]	Total Area Sampled [ha][(b)]	Relative Population Density [Individuals/ha][(c)]		
			Boreal Chorus Frog	Wood Frog	Western Toad
Ecosite Phase					
a1	lichen jack pine	47	0.11	0.02	-
b1	blueberry jack pine-aspen	58	0.52	-	0.14
b2	blueberry aspen (white birch)	11	0.37	0.18	0.19
b3	blueberry aspen-white spruce	3	-	-	-
b4	blueberry white spruce-jack pine	4	6.75	0.68	-
c1	Labrador tea–mesic jack pine-black spruce	275	0.90	0.31	0.06
d1	low-bush cranberry aspen	85	0.76	0.12	0.04
d2	low-bush cranberry aspen-white spruce	16	-	-	-
d3	low-bush cranberry white spruce	2	-	-	-
e1	dogwood balsam poplar-aspen	<1	-	-	-
e2	dogwood balsam poplar-white spruce	8	8.02	-	-
g1	Labrador tea–subhygric black spruce-jack pine	226	0.94	0.59	0.04
h1	Labrador tea/horsetail white spruce-black spruce	4	-	-	-
	ecosite subtotal	*738*	*n/a*	*n/a*	*n/a*
Wetlands Type					
B TNI	wooded bog with internal lawns	6	-	-	0.34
BTNN	wooded bog	183	1.76	0.42	0.10
FONG	graminoid fen	216	0.47	0.02	0.10
FONS	shrubby fen	360	0.40	0.03	0.07
FTNI	wooded fen with internal lawns	10	-	-	-
FTNN	wooded fen	553	0.98	0.41	0.09
MONG	graminoid marsh	15	6.72	4.23	2.62
SONS	shrubby swamp	42	2.96	3.12	0.60
STNN	wooded swamp	29	5.38	0.10	0.49
WONN	shallow open water	18	3.66	0.28	1.41
	wetlands subtotal	*1,431*	*n/a*	*n/a*	*n/a*
Other					
BUu	burned upland	380	0.01	-	0.01
BUw	burned wetland	130	1.02	0.09	0.09
CC	clearcut	3	-	-	-
DIS	disturbed	284	1.77	0.51	0.17
Lake	lake	151	0.61	0.80	-
Me	meadow	68	-	-	-
Sh	shrubland	8	3.78	-	-
	other subtotal	*1,023*	*n/a*	*n/a*	*n/a*
Total		**3,192**	**n/a**	**n/a**	**n/a**

(a) Beckingham and Archibald (1996); Halsey et al. (2003).

(b) Area of suitable habitat sampled within a 250-m listening radius of the plot centre, discounting for some effort overlap within survey years.

(c) Population density is calculated by dividing the number of individuals observed by the total area of a land cover sampled. However, it is not assumed that amphibian populations are evenly distributed within a land cover type.

- = No observations recorded.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 18 Number of Amphibian Observations in and Around the Local Study Area, 2001, 2008, 2011 and 2012

Survey Dates	Number of Plots	Number of Observations[a]			
		Boreal Chorus Frog	Wood Frog	Western Toad	Total
May 7-10 and 21-24, 2001	60	1,881	1,000	131	3,012
May 22-23 and June 2-3, 2008	27	905	18	64	987
June 2 and 4-9, 2011	71	115	8	113	236
June 5-6, 2012	15	57	2	8	67
Total	**173**	**2,958**	**1,028**	**316**	**4,302**

(a) Observations for boreal chorus frogs and wood frogs include estimates of relative abundance and assumed a full chorus (i.e., call index rank of 3) to equal 30 boreal chorus frogs, 59 wood frogs (Stevens and Paszkowski 2004) and 8 western toads.

3.9.3 Distribution

Boreal chorus frogs were recorded in 62% of the upland ecosite phases, 80% of the wetlands types and 71% of the other land cover types surveyed (Table 17). Relative boreal chorus frog density (number of individuals detected per hectare) was highest in the dogwood balsam poplar-white spruce (e2) ecosite phase, followed by blueberry white spruce-jack pine (b4) and graminoid marsh (MONG) land cover types.

Wood frogs were recorded in 46% of the upland ecosite phases, 80% of the wetlands types and 43% of the other land cover types surveyed (Table 17). Relative wood frog density was highest in the graminoid marsh (MONG) wetlands type, followed by shrubby swamp (SONS).

Western toads were recorded in 38% of the upland ecosite phases, 90% of the wetlands types and 43% of the other land cover types surveyed (Table 17). Relative western toad density was highest in the graminoid marsh (MONG) wetlands type, followed by shallow open water (WONN).

Observed amphibian species richness and distribution in and around the LSA was generally within the range of other projects in the RSA (Attachment E, Table E-44); however, Canadian toads were not detected during surveys conducted for the Project, they were for the Christina Lake Thermal Expansion Project (EnCana 2009).

3.10 INCIDENTAL WILDLIFE SIGHTINGS

Incidental wildlife sightings, including visual and auditory identification and the presence of sign (i.e., tracks or scat), were recorded during each wildlife survey and are summarized in Appendix C. Focus was placed on detecting and reporting species of concern (Section 3.11) and not all observations of common species were recorded. By focusing on species of concern, incidental observations provide an opportunity to record the presence of species for which no formal surveys are conducted, or that are detected outside of the parameters of a formal survey. Examples of such species that were recorded incidentally in and around the LSA include sandhill crane, short-eared owl, pied-billed grebe and bay-breasted warbler.

3.11 SPECIES OF CONCERN

Species of concern include all federally or provincially listed species, wildlife population-level Cumulative Environmental Management Association Sustainable Ecosystems Working Group (CEMA-SEWG) ratified environmental indicators, and select species or communities identified as culturally and economically important that were detected in and around the LSA during field surveys or incidentally, or for which FWMIS records are available. Forty-three species of concern were recorded for the Project (Table 19). Incidental observations of listed species detected during field surveys conducted for the Project, as well as FWMIS records for these species, are illustrated on Figures 15, 16 and 17. All species of concern were discussed in Section 7 of the Wildlife Baseline Report (Canadian Natural 2011). New species of concern that were detected during the additional field surveys conducted in 2012 (e.g. short-eared owl), or that are now considered of concern due to upgraded provincial or federal listings (e.g. little brown myotis), are discussed below.

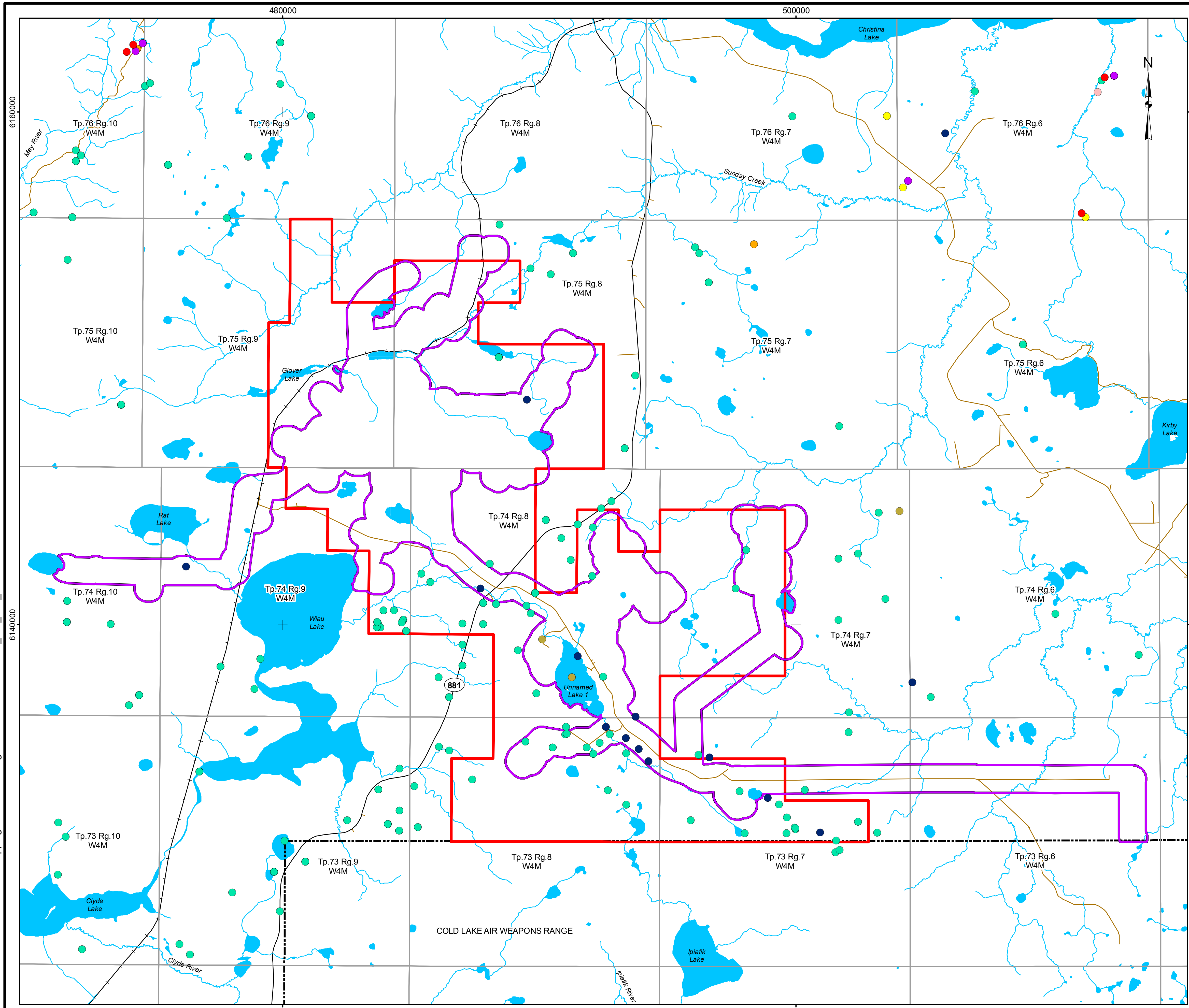
3.11.1 Little Brown Myotis

Little brown myotis are listed as “Endangered” federally (COSEWIC 2012a) and “Secure” in Alberta (ESRD 2011). Although a common species, little brown myotis populations are predicted to become extirpated from the northeastern United States within the next several years due to White-nose Syndrome (WNS) (COSEWIC 2012b). White-nose Syndrome is a fungal disease that has caused massive mortality events for little brown myotis, northern myotis and eastern pipistrelle (tri-colored bat), among other bat species in eastern North America (COSEWIC 2012b, U.S. Fish & Wildlife 2012a). These mortality events will likely continue to spread west through the caves used as winter hibernacula, causing further population declines (COSEWIC 2012b). As of autumn 2012, WNS has not been recorded in Canada west of Ontario (U.S. Fish & Wildlife 2012b).

Table 19 Species and Bird Communities of Special Concern Observed Within the Local Study Area

Species[(a)]	Federal Status[(b)]	Provincial Status[(c)]
Mammals		
beaver	n/a	Secure
black bear	Not at Risk	Secure
Canada lynx	Not at Risk	Sensitive
fisher	n/a	Sensitive
hoary bat	n/a	Sensitive
little brown myotis	Endangered	Secure
moose	n/a	Secure
northern myotis	Endangered	May Be at Risk
red bat	n/a	Sensitive
silver-haired bat	n/a	Sensitive
woodland caribou	Threatened[(d)]	At Risk
Birds		
American bittern	n/a	Sensitive
American kestrel	n/a	Sensitive
bald eagle	Not at Risk	Sensitive
barn swallow	Threatened	Sensitive
bay-breasted warbler	n/a	Sensitive
black-backed woodpecker	n/a	Sensitive
black tern	Not at Risk	Sensitive
brown creeper	n/a	Sensitive
Canada warbler	Threatened[(d)]	Sensitive
Cape May warbler	n/a	Sensitive
common nighthawk	Threatened[(d)]	Sensitive
common yellowthroat	n/a	Sensitive
great blue heron	n/a	Sensitive
great gray owl	Not at Risk	Sensitive
green-winged teal	n/a	Sensitive
least flycatcher	n/a	Sensitive
northern goshawk	Not at Risk	Sensitive
northern harrier	Not at Risk	Sensitive
olive-sided flycatcher	Threatened[(d)]	May Be at Risk
osprey	n/a	Sensitive
pied-billed grebe	n/a	Sensitive
pileated woodpecker	n/a	Sensitive
rusty blackbird	Special Concern[(d)]	Sensitive
sandhill crane	n/a	Sensitive
sedge wren[(e)]	Not at Risk	Sensitive
sharp-tailed grouse	n/a	Sensitive
short-eared owl	Special Concern[(d)]	May Be at Risk
sora	n/a	Sensitive
Swainson's hawk	n/a	Sensitive
western tanager	n/a	Sensitive
western wood-pewee	n/a	Sensitive
ducks and geese	n/a	n/a
mixedwood forest bird community	n/a	n/a
old growth forest bird community	n/a	n/a
Amphibians		
western toad	Special Concern[(d)]	Sensitive

(a) Italicized entries are ratified CEMA-SEWG wildlife indicators for long-term monitoring (CEMA 2006).
(b) COSEWIC (2012a).
(c) ESRD (2011).
(d) On Schedule 1 of SARA (Species at Risk Public Registry 2012).
(e) Sedge wren was not included as a Species of Concern in the 2011 Wildlife Baseline Report (Canadian Natural 2011). The life history description for this species can be found in Section 3.11.2.
n/a = Not applicable.



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LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

SPECIES OBSERVATIONS

- CANADA LYNX
- FISHER
- HOARY BAT
- LITTLE BROWN MYOTIS
- NORTHERN MYOTIS
- RED BAT
- SILVER-HAIRED BAT
- WOODLAND CARIBOU

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

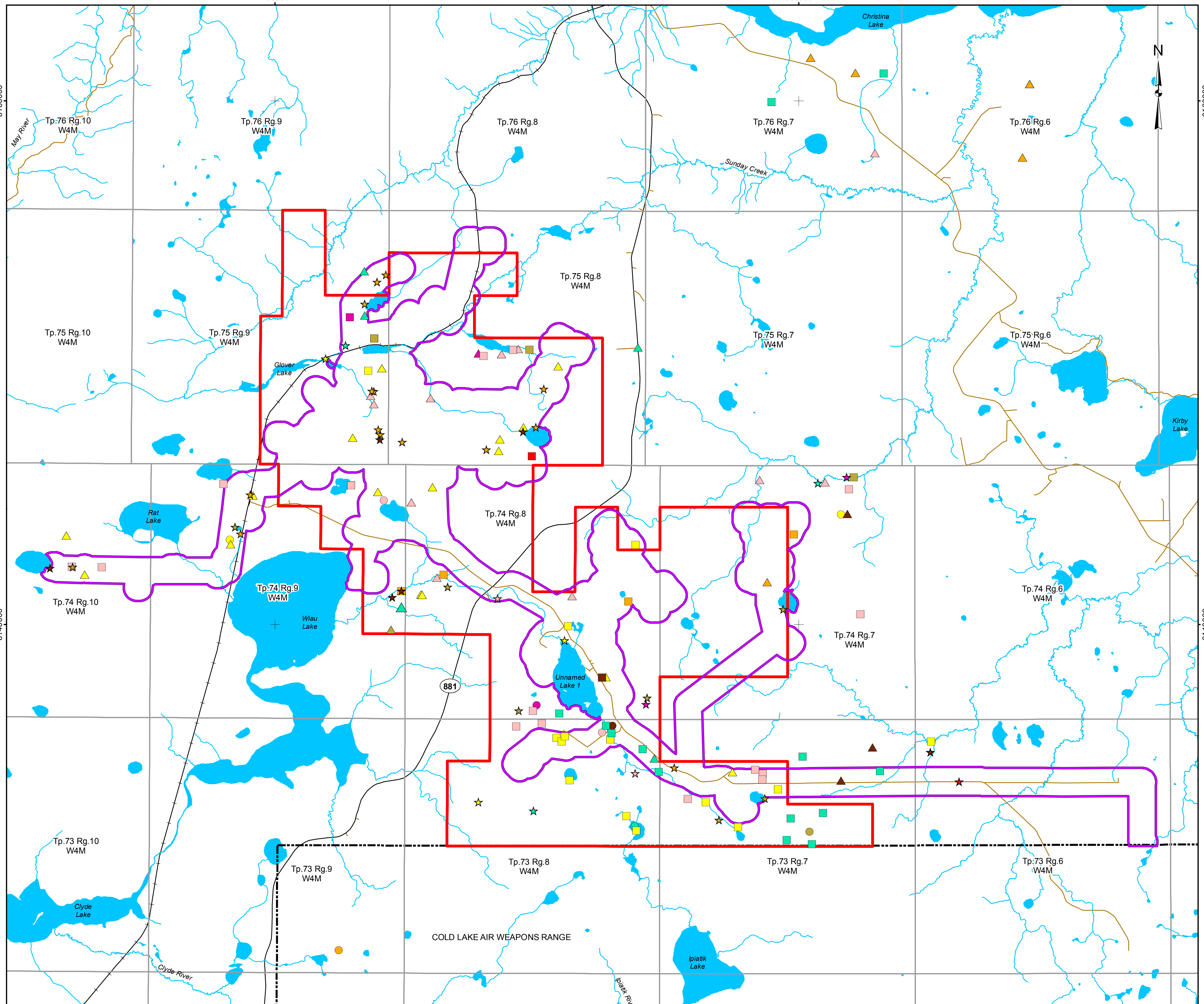
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

FISH AND WILDLIFE MANAGEMENT INFORMATION SYSTEM AND INCIDENTAL LISTED MAMMALS OBSERVED IN AND AROUND THE LOCAL STUDY AREA

Golder Associates

PROJECT		12-1346-0014	FILE No.
DESIGN	JG	5 Sep. 2012	SCALE AS SHOWN REV. 0
GIS	GU	21 Nov. 2012	
CHECK	JG	11 Dec. 2012	**FIGURE: 15**
REVIEW	JV	11 Dec. 2012	



LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

SPECIES OBSERVATIONS

- AMERICAN BITTERN
- AMERICAN KESTREL
- BALD EAGLE
- BAY-BREASTED WARBLER
- BLACK TERN
- BLACK-BACKED WOODPECKER
- BARN SWALLOW
- BROWN CREEPER
- CANADA WARBLER
- CAPE MAY WARBLER
- COMMON NIGHTHAWK
- COMMON YELLOWTHROAT
- GREAT BLUE HERON
- GREAT GRAY OWL
- GREEN-WINGED TEAL
- LEAST FLYCATCHER
- NORTHERN GOSHAWK
- NORTHERN HARRIER
- OLIVE-SIDED FLYCATCHER
- OSPREY
- PIED-BILLED GREBE
- PILEATED WOODPECKER
- RUSTY BLACKBIRD
- SANDHILL CRANE
- SHARP-TAILED GROUSE
- SORA
- SHORT-EARED OWL
- SWAINSON'S HAWK
- WESTERN TANAGER
- WESTERN WOOD-PEWEE

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
Canadian Natural
KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE
FISH AND WILDLIFE MANAGEMENT INFORMATION SYSTEM AND INCIDENTAL LISTED BIRDS OBSERVED IN AND AROUND THE LOCAL STUDY AREA

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	JG	5 Sep. 2012	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012	FIGURE: 16	
CHECK	JG	11 Dec. 2012		
REVIEW	JV	11 Dec. 2012		

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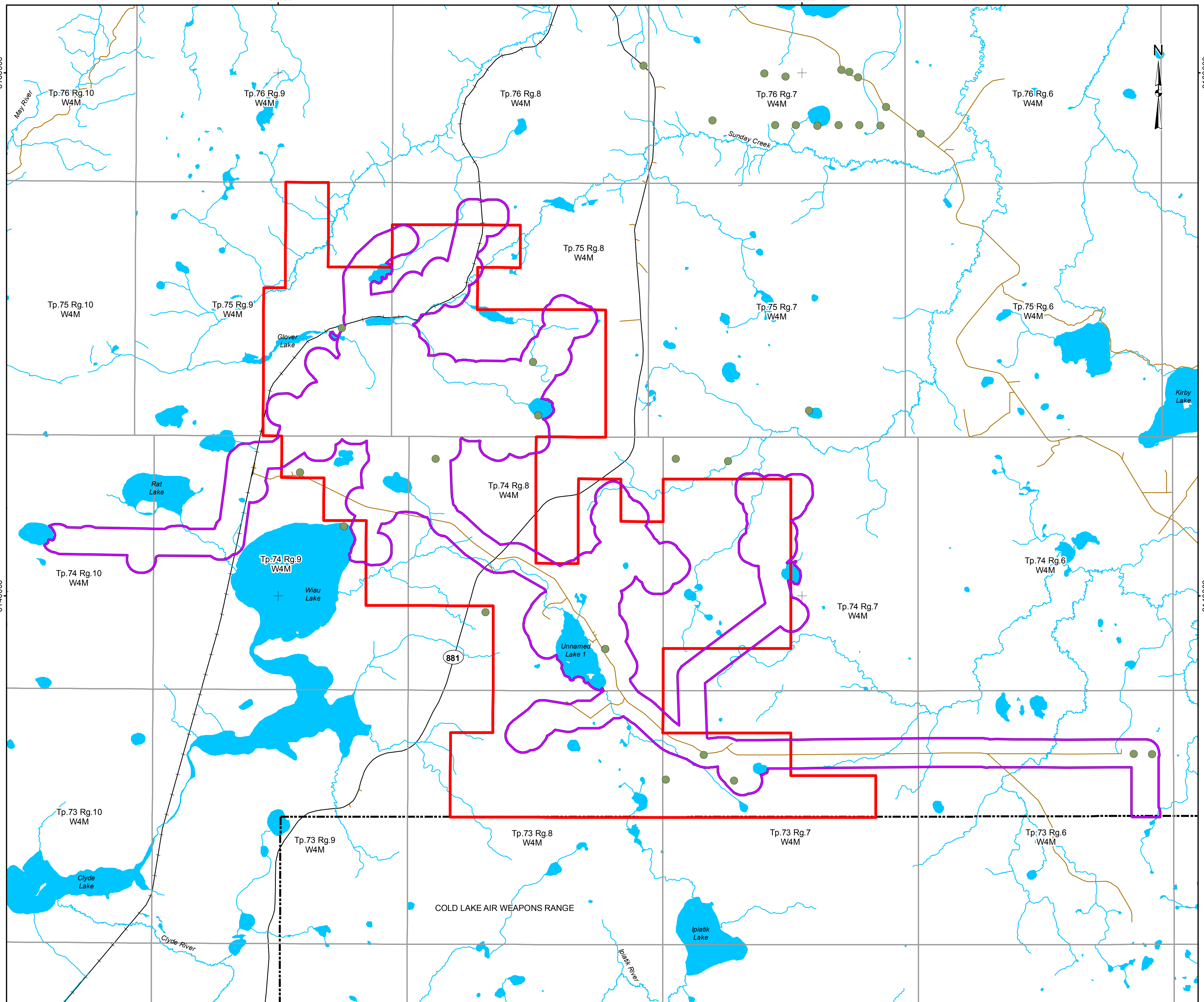

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- RAILROAD
- PROPOSED KIRBY EXPANSION PROJECT AREA *
- OPEN WATER
- TERRESTRIAL RESOURCES LOCAL STUDY AREA

SPECIES OBSERVATIONS

- WESTERN TOAD

NOTE

* OIL SANDS LEASES FULLY HELD BY CANADIAN NATURAL
ONE SPECIES OBSERVATION POINT MAY REPRESENT MORE THAN ONE INDIVIDUAL OBSERVED.
EXISTING DISTURBANCE LAYER NOT SHOWN FOR FIGURE CLARITY

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DATUM: NAD 83 PROJECTION: UTM ZONE 12

5 0 5

SCALE 1:150,000 KILOMETRES

PROJECT

Canadian Natural

KIRBY IN SITU OIL SANDS EXPANSION PROJECT

TITLE

FISH AND WILDLIFE MANAGEMENT INFORMATION SYSTEM AND INCIDENTAL WESTERN TOADS OBSERVED IN AND AROUND THE LOCAL STUDY AREA

Golder Associates

PROJECT		12-1346-0014	FILE No.	
DESIGN	JG	5 Sep. 2012	SCALE AS SHOWN	REV. 0
GIS	GU	21 Nov. 2012		
CHECK	JG	11 Dec. 2012	**FIGURE: 17**	
REVIEW	JV	11 Dec. 2012		

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Little brown myotis are commonly found in mixedwood and coniferous forests during the spring, summer and fall (ASRD and ACA 2009; Smith 1993). These bats mate in the fall but fertilization is delayed until spring, with generally one young born (Pattie and Fisher 1999). During the winter months, they hibernate in caves. The main limiting factor for little brown myotis in Alberta is the absence of suitable hibernacula, typically caves, and the loss of roosting habitat such as old growth trees. Females will also roost in groups in unoccupied buildings or attics during the warmer months (ESRD 2012). When the number of hibernacula is low, bat populations are clumped and the risk of effects from predation (Caceres and Pybus 1997) and disease (U.S. Fish & Wildlife 2012a) are increased.

Little brown myotis captures and detections in the Oil Sands Region since 1993 are described in Table E-34, Attachment E. Twenty little brown myotis were captured at mist-nets plots in and around the LSA (Figure 9). Little brown myotis activity was recorded at acoustic detection plots at an average of 2.4 passes/hr and in 64% of the land cover types sampled. The FWMIS database includes 12 records of little brown myotis in and around the LSA (Figure 15).

3.11.2 Sedge Wren

Sedge wrens are listed as “Sensitive” in Alberta and populations are thought to have decreased across their Alberta range since 1966, to between 2,000-10,000 individuals (ESRD 2011). Drought conditions combined with drainage of wetlands have degraded nesting habitats (ESRD 2011). Sedge wrens are listed as “Not at Risk” federally (COSEWIC 2012a).

Sedge wrens nest among dense, tall growth of sedges and grasses in wet meadows, hayfields, retired croplands, upland margins of ponds and marshes, coastal marshes, and sphagnum bogs (Herkert et al. 2001). One sedge wren was observed in a shrubby fen (FONS) in the LSA in 2011 (Figure 13). There have been no other detections of sedge wrens in the Oil Sands Region since 2001 (Attachment F, Table F-1).

3.11.3 Short-eared Owl

Short-eared owl are listed as “Special Concern” federally (COSEWIC 2012a) and “May Be at Risk” in Alberta (ESRD 2011). This species has been experiencing a sustained population decline over the past 45 years, primarily due to habitat loss and degradation on its wintering grounds (COSEWIC 2008). Habitat loss and degradation on its breeding grounds in southern Canada and pesticide use are secondary threats (COSEWIC 2008). The population size of short-eared owls in Alberta is unknown (ESRD 2011).

This medium-sized owl is found throughout Alberta east of the Rocky Mountains and favours open habitats such as grasslands, marshes, peatlands and clear cuts (Clayton 2000). In Alberta, the short-eared owl is most often reported in the Grassland and Aspen Parkland Natural Regions (Semenchuk 1992). The species routinely nests on the ground and prey availability is usually the main factor that determines breeding locations (Wiggins et al. 2006). Small mammals, particularly voles (*Microtus* genus), dominate the short-eared owl's diet in North America (Wiggins et al. 2006). One short-eared owl was recorded incidentally in a shrubby swamp (SONS) in the LSA during field surveys conducted in 2012 (Figure 16).

4 SUMMARY

Baseline wildlife surveys were completed from 2001 to 2011 to support an EIA for the Project. These results can be found in the Wildlife Baseline Report submitted with the Project EIA (Canadian Natural 2011). Surveys completed included:

- ungulate aerial surveys;
- winter track count surveys;
- photographic bait stations;
- beaver/muskrat surveys;
- bat surveys;
- owl surveys;
- marsh bird surveys;
- yellow rail surveys;
- horned grebe surveys;
- breeding songbird surveys;
- common nighthawk surveys; and
- amphibian surveys.

Where access was available, additional winter track count, bat, owl, marsh bird, yellow rail, horned grebe, breeding songbird, common nighthawk, and amphibian surveys were conducted in 2012 to provide more complete coverage of the east central, central and eastern portions of the Project Area (SIR 206 [Canadian Natural 2012]). Data collected for the Project were compared to those from EIAs and baseline reports completed for other projects in the RSA to better determine conditions in the broader landscape.

Forty-three species of concern were recorded in and around the LSA during baseline field surveys or incidentally. These include listed species such as Canada lynx, fisher, hoary bat, little brown myotis, northern myotis, red bat, silver-haired bat, western toad, woodland caribou and 31 bird species. Other species of concern recorded for the Project include beaver, black bear and moose, all of which are considered secure in the province, but are of concern due to their high social, traditional and economic importance. Black bear, fisher and moose are also environmental indicators ratified by the SEWG of CEMA.

5 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

GOLDER ASSOCIATES LTD.

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Report reviewed by:

John Virgl, Ph.D Biology
Associate, Senior Ecologist

6 REFERENCES

ACA and ASRD (Alberta Conservation Association and Alberta Sustainable Resource Development). 2006. *Alberta Volunteer Amphibian Monitoring Program–Participants Manual*. Alberta Conservation Association, Edmonton, AB. 46 pp.

ASRD and ACA (Alberta Sustainable Resource Development and Alberta Conservation Association). 2009. *Status of Northern Myotis (*Myotis septentrionalis*) in Alberta: Update 2009*. Alberta Wildlife Status Report No. 3 (Update 2009). Edmonton, AB. 34pp. Available online at: http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/DetailedStatus/Mammals/documents/Status-NLongEaredBatMyotis-inAlberta-May2009.pdf. Accessed August 23, 2012.

Beckingham, J.D. and J.H. Archibald. 1996. *Field Guide to Ecosites of Northern Alberta*. Natural Resources Canada. Canadian Forest Service, Northwest Region, Northern Forestry Centre. Special Report 5. Edmonton, AB.

Caceres, M.C. and M.J. Pybus. 1997. *Status of the Northern Long-Eared Bat (Myotis septentrioalis) in Alberta*. Wildlife Status Report No. 3. Wildlife Management Division, Alberta Environmental Protection. Edmonton, AB. 19 pp.

Canadian Natural (Canadian Natural Resources Limited). 2011. *Kirby In Situ Oil Sands Expansion Project Application for Approval*. Submitted to Energy Resources Conservation Board and Alberta Environment and Water. December 2011. Calgary, AB.

CEMA (Cumulative Environmental Management Association). 2006. *Sustainable Ecosystem Working Group (SEWG) Ratified Indicator List*. Fort McMurray, AB. 1 pp.

Cenovus (Cenovus FCCL Ltd). 2010. *Application for Approval of the Cenovus Narrows Lake Project*. Integrated Application and Environmental Impact Assessment. Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment, June 2010. Calgary, AB.

Clayton, K.M. 2000. *Status of the short-eared owl* (Asio flammeus) *in Alberta*. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 28, Edmonton, AB. 15 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2008. *COSEWIC assessment and update status report on the Short-eared Owl Asio flammeus in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 24 pp. Available online at: http://www.publications.gc.ca/collections/collection_2008/ec/CW69-14-7-2008E.pdf. Accessed September 21, 2012.

COSEWIC. 2012a. *Canadian Species at Risk Database*. Canadian Wildlife Service, Environment Canada. Ottawa, ON. Available online at: http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm. Accessed August 20, 2012.

COSEWIC 2012b. *Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis*, Myotis lucifugus. Graham Forbes, Co-Chair, Terrestrial Mammal Subcommittee, COSEWIC. Available online at: http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/ca_petite_chauvesouris_little_brown_myotis_0212_e.pdf. Accessed on August 23, 2012.

EnCana (EnCana Oil & Gas Partnership). 2005. *EnCana Oil & Gas Partnership: Christina Lake Thermal Project Phase 1B Environmental Impact Assessment*. May 2005. EnCana Oil & Gas Partnership. Prepared by Golder Associates Ltd.

EnCana (EnCana FCCL Ltd.). 2009. *Application for Approval of the EnCana Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G*. Integrated Application and Environmental Impact Assessment. Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment, October 2009. Calgary, AB.

ESRD (Environment and Sustainable Resource Development). 2011. *The General Status of Alberta Wild Species 2010*. Alberta Environment and Sustainable Resource Development, Fish & Wildlife Service Division. http://www.srd.alberta.ca/FishWildlife/SpeciesAtRisk/GeneralStatusOfAlbertaWildSpecies/Default.aspx. Accessed August 23, 2012.

ESRD. 2012. *Wildlife Species: Bats*. Available online at: http://www.srd.alberta.ca/FishWildlife/WildSpecies/Mammals/Bats/Default.aspx. Accessed August 23, 2012.

Fisher, J.T., L. Takats Priestley, T. Muhly, D. Huggard, E. Bayne, and S. Nielsen. 2011. *Recommendations for an Owl Monitoring Pilot Study in Northeast Alberta*. Rare Animals Monitoring Team. Ecological Monitoring Committee for the Lower Athabasca, Alberta. 75 pp. Available online at: http://emcla.ca/wp-content/uploads/2012/05/EMCLA-Owl-Report-2011_FINAL.pdf. Accessed December 4, 2012.

Gulf (Gulf Canada Resources Ltd.). 2001. *Application for the Approval of the Surmont In-Situ Oil Sands Project*. Prepared for Gulf Canada Resources Limited by Colt Engineering Corporation, AXYS Environmental Consulting Ltd., Campbell & Associates Ltd., Matrix Solutions Inc. and Nichols Applied Management. March 2001. Volumes 1 to 3 + 6 Appendices.

Halsey, L.A., D.H. Vitt, D. Beilman, S. Crow, S. Mehelcic and R. Wells. 2003. *Alberta Wetlands Inventory Standards, Version 2.0*. Alberta Sustainable Resource Development, Resource Data Branch. Edmonton, AB. 54 pp. ISBN: 0778523233.

Herkert, J.R., D.E. Kroodsma and J.P. Gibbs. 2001. Sedge Wren (*Cistothorus platensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/582. Accessed August 27, 2012.

Krebs, C.J. 2009. *Ecology: the experimental analysis of distribution and abundance (sixth edition)*. Pearson Benjamin Cummings, San Francisco, CA. 655 pp.

MEG (MEG Energy Corp.). 2005. *Application for Approval of the Christina Lake Regional Project*. Volumes 1 to 5. Submitted to Alberta Environment and Alberta Energy and Utilities Board. Calgary, AB. Submitted August 2005.

MEG. 2008. *Christina Lake Regional Project - Phase 3 Wildlife Environmental Setting Report*. Prepared for MEG Energy Corp., Calgary, AB.

OPTI (OPTI Canada Inc.). 2000. *Long Lake Project Application for Approval to Alberta Energy and Utilities Board and to Alberta Environment*. Volume 1 (Application) and Volumes 2 to 7 (EIA). December 2000. Calgary, AB.

Pattie, D. and C. Fisher. 1999. *Mammals of Alberta*. Lone Pine Publishing. Edmonton, AB. 240 pp.

Petro-Canada (Petro-Canada Oil and Gas). 2001. *Application for the Approval of the Meadow Creek Project*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. November 2001.

Semenchuk, G.P. 1992. *The Atlas of Breeding Birds of Alberta*. Federation of Alberta Naturalists. Edmonton, AB. 393 pp.

Smith, H.C. 1993. *Alberta Mammals: An Atlas and Guide*. The Provincial Museum of Alberta. Edmonton, AB. 239 pp. + Maps.

Species at Risk Public Registry. 2012. http://www.registrelep-sararegistry.gc.ca. Accessed August 8, 2012.

Stedman, S. J. 2000. *Horned Grebe (*Podiceps auritus*)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/505. Accessed September 21, 2012.

Stevens, C.E. and C.A. Paszkowski. 2004. *Using Reproductive Chorus-Ranks from Call Surveys to Estimate Reproductive Activity of the Wood Frog (Rana sylvatica)*. Journal of Herpetology. 38. 3. p. 404-410.

U.S. Fish & Wildlife Service. 2012a. White-Nose Syndrome Fact Sheet. Available online: http://www.fws.gov/WhiteNoseSyndrome/about.html. Accessed on August 23, 2012.

U.S. Fish & Wildlife Service. 2012b. White-Nose Syndrome Maps. Available online: http://www.fws.gov/WhiteNoseSyndrome/maps.html. Accessed on August 20, 2012.

Wiggins, D.A., D.W. Holt and S.M. Leasure. 2006. *Short-eared owl (Asio flammeus)*. The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology. Available online: http://bna.birds.cornell.edu/bna/species/062. Accessed on September 21, 2012.

7 ABBREVIATIONS

%	Percent
<	Less than
>	More than
±	Plus or minus
°C	degrees Celsius
Canadian Natural	Canadian Natural Resources Limited
CEMA	Cumulative Environmental Management Association
Cenovus	Cenovus FCCL Ltd.
cm or cm^2	Centimetre or square centimetre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
e.g.	For example
EIA	Environmental Impact Assessment
ESRD	Environment and Sustainable Resource Development
et al.	And others
FWMIS	Fish and Wildlife Management Information System
Golder	Golder Associates Ltd.
ha	Hectare
hr	Hour
i.e.	That is
KIR	Key Indicator Resource
km or km^2	Kilometre or square kilometre
km/h	Kilometres per hour
LSA	Local Study Area
m or m^2	Metre or square metre
MEG	MEG Energy Corp.
Petro-Canada	Petro-Canada Oil and Gas
RSA	Regional Study Area
SARA	*Species at Risk Act*
SD	Standard Deviation
SEWG	Sustainable Ecosystems Working Group of CEMA
the Project	Kirby In Situ Oil Sands Expansion Project
the Project Area	Kirby Expansion Project Area
W4M	West of the Fourth Meridian

8 GLOSSARY

Biodiversity The variety of plant and animal life in a particular habitat (e.g., plant community or a country). It includes all levels of organization, from genes to landscapes, and the ecological processes through which these levels are connected.

Bog Ombrotophic, acidic, peat-forming wetlands that receives its surface moisture from precipitation. Characterized by a level, raised or sloping peat surface with hollows and hummocks.

Boreal Forest The northern hemisphere, circumpolar, tundra forest type consisting primarily of black spruce and white spruce with balsam fir, birch and aspen.

Canid Any animal of the family *Canidae*, a family of mammals including dogs, jackals, wolves and foxes, typically having a bushy tail, erect ears and a long muzzle: order *Carnivora* (carnivores).

Canopy An overhanging cover, shelter or shade. The tallest layer of vegetation in an area.

Carnivore Any of an order of mammals that feed chiefly on flesh or other animal matter rather than plants.

Clearcut Previously forested area that has been harvested for timber and is presently regenerating at various stages of regrowth.

Coniferous Bearing cones or strobili (a cone-like cluster).

Cumulative Environmental Management Association (CEMA) An association of oil sands industry, other industry, regional community representatives, regulatory agencies and other stakeholders designed to develop systems to manage cumulative effects associated with developments in the Oil Sands Region.

Deciduous Tree species that lose their leaves at the end of the growing season.

Ecosite Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.

Ecosite Phase A subdivision of the ecosite based on the dominant tree species in the canopy. On some sites where the tree canopy is lacking, the tallest structural vegetation layer determines the ecosite phase.

Ecosystem An integrated and stable association of living and non-living resources functioning within a defined physical location. A community of organisms and its environment functioning as an ecological unit. For the purposes of assessment, the ecosystem must be defined according to a particular unit and scale.

Extirpated A species no longer existing in the wild within a geographic area that it was formally present, but which still exists elsewhere in the world.

Fen Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in a eutrophic environment due to the close association of the material with mineral rich waters. Minerotropic peat-forming wetlands that receive surface moisture from precipitation and groundwater. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium.

Graminoid Grasses and grass-like plants such as sedges and rushes.

Guild A set of co-existing species that share a common resource.

Habitat The place or environment where a plant or animal naturally or normally lives or occurs.

Hibernacula The shelter chosen by an animal for hibernation during winter.

Home Range The area within which an animal normally lives, and traverses as part of its annual travel patterns.

Lichen Any complex organism of the group Lichenes, composed of a fungus in symbiotic union with an alga and having a greenish, grey, yellow, brown, or blackish thallus that grows in leaflike, crustlike, or branching forms on rocks, trees and other surfaces.

Linear Disturbance Cutlines, pipelines, rights-of-ways, and transmission lines (but not roads).

Local Study Area (LSA) Defines the spatial extent directly or indirectly affected by the project.

Mean Centroid value of a data population when viewing its probability distribution function (or histogram) as a mass distribution.

Mesic A moderate soil moisture regime value whereby water is removed somewhat slowly in relation to supply; neither wet nor dry. Available soil water reflects climatic inputs.

Mixedwood A terrestrial forest type that is an assemblage of both deciduous and coniferous tree species.

Oil Sands Region The Oil Sands Region includes the Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP.

Old Growth Forest An ecosystem distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species, composition, and ecosystem function. Old growth forests are those forested areas where the annual growth equals annual losses, or where the mean annual increment of timber volume equals zero. They can be defined as those stands that are self-regenerating (i.e., having a specific structure that is maintained).

Patterned Fen Peatlands that display a distinctive pattern due to alterations between open wet areas (flarks) and drier shrubby to wooded areas (strings).

Peatland Areas where there is an accumulation of peat material at least 40 cm thick. These are represented by bog and fen wetlands types.

Point Count A circular plot survey where observers spend a prescribed time looking and listening for birds.

Regional Study Area (RSA) Defines the spatial extent related to the cumulative effects resulting from the project and other regional developments.

Relative Abundance The proportional representation of a species in a sample or a community.

Riparian Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain or standing waterbody.

Sedge Any plant of the genus *Carex*, perennial herbs, often growing in dense tufts in marshy places. They have triangular jointless stems, a spiked inflorescence and long grass-like leaves which are usually rough on the margins and midrib. There are several hundred species.

Shannon Diversity Index A diversity measure based on information theory, a measure of species richness and evenness in the number of individuals per species within a particular system. Greater values represent greater diversity. The Shannon Diversity Index is represented by:

$$H = -\sum_{i=1}^{s} (p_i)(\log_2 p_i)$$

Species A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.

Species Abundance The number of individuals of a particular species within a biological community (e.g., habitat).

Species Diversity A description of a biological community that includes both the number of different species and their relative abundance. Provides a measure of the variation in number of species in a region. This variation depends partly on the variety of habitats and the variety of resources within habitats and, in part, on the degree of specialization to particular habitats and resources.

Species Richness The number of different species occupying a given area.

Standard Deviation (SD) A measure of the variability or spread of the measurements about the mean. It is calculated as the positive square root of the variance.

Subhygric Soil moisture conditions where water is removed slowly enough to keep the soil wet for a significant part of the growing season. There is some temporary seepage and possible mottling below 20 cm.

Swamp Land having soils that are saturated with water for at least part of the year and which usually occur next to waterbodies or in areas in association with fluctuating water levels such as along peatland margins.

Terrestrial Vegetation Forested or non-forested areas of the landscape with non-saturated and non-peat-forming soils. Excludes bogs, fens, swamps and marshes.

Transect A method of sampling vegetation, along a path or fixed line.

Ungulate Species belonging to the order Artiodactyla (formerly Ungulata), and composed of the hoofed mammals. Horns or antlers are present on males and occasionally on females. In Alberta, there are three families represented by nine species, such as caribou, moose and deer.

Uplands Areas that have typical ground slopes of 1 to 3% and have good drainage.

Waterbody A general term that refers to ponds, bays, lakes, estuaries and marine areas.

Watercourse A general term that refers to riverine systems such as creeks, brooks, streams and rivers.

Wetlands Wetlands are land where the water table is at, near or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or “peatlands,” and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat.

Wildlife Under the *Species at Risk Act*, wildlife is defined as a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus that is wild by nature and is native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.

ATTACHMENT A

COMMON NAMES, SCIENTIFIC NAMES AND STATUS OF SPECIES OBSERVED

Table A-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Area

Common Name	Scientific Name	Federal Status[(a)]	Provincial Status[(b)]
Mammals			
beaver	*Castor canadensis*	-	Secure
black bear	*Ursus americanus*	Not At Risk	Secure
Canada lynx	*Lynx canadensis*	Not At Risk	Sensitive
coyote	*Canis latrans*	-	Secure
fisher	*Martes pennanti*	-	Sensitive
grey wolf	*Canis lupus*	Not At Risk	Secure
hoary bat	*Lasiurus cinereus*	-	Sensitive
little brown myotis	*Myotis lucifugus*	Endangered	Secure
marten	*Martes americana*	-	Secure
moose	*Alces alces*	-	Secure
muskrat	*Ondatra zibethicus*	-	Secure
northern myotis	*Myotis septentrionalis*	Endangered	May Be at Risk
porcupine	*Erethizon dorsatum*	-	Secure
red bat	*Lasiurus borealis*	-	Sensitive
red squirrel	*Tamiasciurus hudsonicus*	-	Secure
red fox	*Vulpes vulpes*	-	Secure
river otter	*Lutra canadensis*	-	Secure
silver-haired bat	*Lasionycteris noctivagans*	-	Sensitive
snowshoe hare	*Lepus americanus*	-	Secure
weasel spp.	*Mustela* spp.	n/a	n/a
white-tailed deer	*Odocoileus virginianus*	-	Secure
woodland caribou	*Rangifer tarandus*	Threatened	At Risk
Amphibians			
boreal chorus frog	*Pseudacris maculaata*	-	Secure
western toad	*Anaxyrus boreas*	Special Concern	Sensitive
wood frog	*Lithobates sylvatica*	-	Secure
Birds			
alder flycatcher	*Empidonax alnorum*	-	Secure
American bittern	*Botaurus lentiginosus*	-	Sensitive
American coot	*Fulica americana*	-	Secure
American crow	*Corvus brachyrhynchos*	-	Secure
American kestrel	*Falco sparverius*	-	Sensitive
American pipit	*Anthus rubescens*	-	Secure
American redstart	*Setophaga ruticilla*	-	Secure
American robin	*Turdus migratorius*	-	Secure
American wigeon	*Anas americana*	-	Secure
bald eagle	*Haliaeetus leucocephalus*	Not At Risk	Sensitive
bank swallow	*Riparia riparia*	-	Secure
barn swallow	*Hirundo rustica*	Threatened	Sensitive
Barrow's goldeneye	*Bucephala islandica*	-	Secure
bay-breasted warbler	*Setophaga castanea*	-	Sensitive
belted kingfisher	*Megaceryle alcyon*	-	Secure
black-and-white warbler	*Mniotilta varia*	-	Secure
black-backed woodpecker	*Picoides arcticus*	-	Sensitive
black-billed magpie	*Pica hudsonia*	-	Secure
black-capped chickadee	*Parus atricapillus*	-	Secure
black poll warbler	*Setophaga striata*	-	Secure

Table A-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Area (continued)

Common Name	Scientific Name	Federal Status[a]	Provincial Status[b]
blue-headed vireo	*Vireo solitarius*	-	Secure
blue-winged teal	*Anas discors*	-	Secure
Bonaparte’s gull	*Larus philadelphia*	-	Secure
boreal chickadee	*Poecile hudsonicus*	-	Secure
boreal owl	*Aegolius funereus*	Not At Risk	Secure
black tern	*Chlidonias niger*	Not At Risk	Sensitive
brown creeper	*Certhia americana*	-	Sensitive
bufflehead	*Bucephala albeola*	-	Secure
Canada goose	*Branta canadensis*	-	Secure
Canada warbler	*Cardellina canadensis*	Threatened	Sensitive
Cape May warbler	*Setophaga tigrina*	-	Sensitive
cedar waxwing	*Bombycilla cedrorum*	-	Secure
chipping sparrow	*Spizella passerina*	-	Secure
clay-colored sparrow	*Spizella pallida*	-	Secure
common loon	*Gavia immer*	Not At Risk	Secure
common merganser	*Mergus merganser*	-	Secure
common nighthawk	*Chordeiles minor*	Threatened	Sensitive
common raven	*Corvus corax*	-	Secure
common yellowthroat	*Geothlypis trichas*	-	Sensitive
common redpoll	*Acanthis flammea*	-	Secure
Connecticut warbler	*Oporornis agilis*	-	Secure
dark-eyed junco	*Junco hyemalis*	-	Secure
eastern kingbird	*Tyrannus tyrannus*	-	Secure
evening grosbeak	*Coccothraustes vespertinus*	-	Secure
golden-crowned kinglet	*Regulus satrapa*	-	Secure
gray jay	*Perisoreus canadensis*	-	Secure
great blue heron	*Ardea herodias*	-	Sensitive
great gray owl	*Strix nebulosa*	Not At Risk	Sensitive
great horned owl	*Bubo virginianus*	-	Secure
greater yellowlegs	*Tringa melanoleuca*	-	Secure
green-winged teal	*Anas crecca*	Secure	Sensitive
grouse spp.	n/a	n/a	n/a
hairy woodpecker	*Picoides villosus*	-	Secure
hermit thrush	*Catharus guttatus*	-	Secure
herring gull	*Larus argentatus*	-	Secure
horned grebe	*Podiceps auritus*	Special Concern	Sensitive
horned lark	*Eremophila alpestris*	-	Secure
killdeer	*Charadrius vociferus*	-	Secure
lapland longspur	*Calcarius lapponicus*	-	Secure
Le Conte’s sparrow	*Ammodramus leconteii*	-	Secure
least flycatcher	*Empidonax minimus*	-	Sensitive
least sandpiper	*Calidris minutilla*	-	Secure
lesser yellowlegs	*Tringa flavipes*	-	Secure
Lincoln's sparrow	*Melospiza lincolnii*	-	Secure
magnolia warbler	*Setophaga magnolia*	-	Secure
mallard	*Anas platyrhynchos*	-	Secure
merlin	*Falco columbarius*	-	Secure
mountain bluebird	*Sialia currucoides*	-	Secure

Table A-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Area (continued)

Common Name	Scientific Name	Federal Status[a]	Provincial Status[b]
mountain chickadee	*Poecile gambeli*	-	Secure
mourning warbler	*Geothlypis philadelphia*	-	Secure
Nashville warbler	*Oreothlypis ruficapilla*	-	Secure
northern flicker	*Colaptes auratus*	-	Secure
northern goshawk	*Accipiter gentilis*	Not At Risk	Sensitive
northern harrier	*Circus cyaneus*	Not At Risk	Sensitive
northern hawk owl	*Surnia ulula*	Not At Risk	Secure
northern waterthrush	*Parkesia noveboracensis*	-	Secure
olive-sided flycatcher	*Contopus cooperi*	Threatened	May Be at Risk
orange-crowned warbler	*Vermivora celata*	-	Secure
osprey	*Pandion haliaetus*	-	Sensitive
ovenbird	*Seiurus aurocapillus*	-	Secure
palm warbler	*Setophaga palmarum*	-	Secure
Philadelphia vireo	*Vireo philadelphicus*	-	Secure
pied-billed grebe	*Podilymbus podiceps*	-	Sensitive
pine siskin	*Spinus pinus*	-	Secure
pileated woodpecker	*Dryocopus pileatus*	-	Sensitive
ptarmigan spp.	*Lagopus* spp.	n/a	n/a
purple finch	*Carpodacus purpureus*	-	Secure
raptor spp.	n/a	n/a	n/a
red-breasted nuthatch	*Sitta canadensis*	-	Secure
red-eyed vireo	*Vireo olivaceus*	-	Secure
red-necked grebe	*Podiceps grisegena*	Not At Risk	Secure
red-tailed hawk	*Buteo jamaicens*	Not At Risk	Secure
red-winged blackbird	*Agelaius phoeniceus*	-	Secure
ring-necked duck	*Aythya collaris*	-	Secure
rose-breasted grosbeak	*Pheucticus ludovicianus*	-	Secure
rough-legged hawk	*Buteo lagopus*	Not At Risk	Secure
ruby-crowned kinglet	*Regulus calendula*	-	Secure
ruffed grouse	*Bonasa umbellus*	-	Secure
rusty blackbird	*Euphagus carolinus*	Special Concern	Sensitive
sandhill crane	*Grus canadensis*	-	Sensitive
sedge wren	*Cistothorus platensis*	-	Secure
sharp-tailed grouse	*Tympanuchus phasianellus*	-	Sensitive
snow bunting	*Plectrophenax nivalis*	-	Secure
snow goose	*Chen caerulescens*	-	Secure
solitary sandpiper	*Tringa solitaria*	-	Secure
song sparrow	*Melospiza melodia*	-	Secure
sora	*Porzana carolina*	-	Sensitive
spotted sandpiper	*Actitis macularius*	-	Secure
spruce grouse	*Falcipennis canadensis*	-	Secure
surf scoter	*Melanitta perspicillata*	-	Secure
Swainson’s hawk	*Buteo swainsoni*	-	Sensitive
Swainson's thrush	*Catharus ustulatus*	-	Secure
swamp sparrow	*Melospiza georgiana*	-	Secure
Tennessee warbler	*Oreothlypis peregrina*	-	Secure
tree swallow	*Tachycineta bicolor*	-	Secure
western tanager	*Piranga ludoviciana*	-	Sensitive

Table A-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Area (continued)

Common Name	Scientific Name	Federal Status[a]	Provincial Status[b]
western wood pewee	*Contopus sordidulus*		Sensitive
white-breasted nuthatch	*Sitta carolinensis*	-	Secure
white-throated sparrow	*Zonotrichia albicollis*	-	Secure
white-winged crossbill	*Loxia leucoptera*	-	Secure
Wilson’s snipe	*Gallinago delicata*	-	Secure
Wilson’s warbler	*Cardellina pusilla*	-	Secure
winter wren	*Troglodytes hiemalis*	-	Secure
woodpecker spp.	n/a	n/a	n/a
yellow warbler	*Setophaga petechia*	-	Secure
yellow-bellied flycatcher	*Empidonax flaviventris*	-	Undetermined
yellow-bellied sapsucker	*Sphyrapicus varius*	-	Secure
yellow-rumped warbler	*Setophaga coronata*	-	Secure

(a) COSEWIC (2012a); Species at Risk Public Registry (2012).

(b) Alberta ESRD (2011).

COSEWIC = Committee on the Status of Endangered Wildlife in Canada; ESRD = Environment and Sustainable Resource Development.

n/a = Not applicable.

- = Indicates that there is currently no federal assessment for the species.

ATTACHMENT B

POTENTIAL AND OBSERVED SPECIES OF CONCERN

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area

Species	Scientific Name	Federal Status (COSEWIC)[a]	Federal Status (SARA)[b]	Provincial Status[c]	CEMA Ratified Indicator[d]	Observed[e]	Habitat Requirements[f]
Mammals							
Chiroptera							
northern myotis	*Myotis septentrionalis*	Endangered	No Schedule: No Status	May Be at Risk	-	yes	southern end of range; mixed and coniferous forests; hibernate in caves
little brown myotis	*Myotis lucifugus*	Endangered	No Schedule: No Status	Secure	-	yes	found throughout most of the country, typically hibernate in caves during winter and roost in trees or buildings during summer
hoary bat	*Lasiurus cinereus*	-	-	Sensitive	-	yes	found throughout most of the country, typically roost in trees along forest borders
red bat	*Lasiurus borealis*	-	-	Sensitive	-	yes	prefer forested environments, forage in a variety of habitats, mostly over land, along the edges of pastures, crop lands or other openings dotted with large deciduous trees
silver-haired bat	*Lasionycteris noctivagans*	-	-	Sensitive	-	yes	most closely associated with coniferous or mixed coniferous and deciduous forest types, especially in areas of old growth
Castoridae							
beaver	*Castor canadensis*	-	-	Secure	-	yes	requires water; sloughs, rivers, creeks and lakes with trees within easy access
Carnivora							
black bear	*Ursus americanus*	Not At Risk	-	Secure	yes	yes	coniferous and mixed forests
fisher	*Martes pennanti*	-	-	Sensitive	yes	yes	dense coniferous forest
wolverine	*Gulo gulo*	Special Concern	No Schedule; No Status	May Be at Risk	-	no	dense forests
Canada lynx	*Lynx canadensis*	Not At Risk	-	Sensitive	-	yes	coniferous and mixedwood forest

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[(a)]	Federal Status (SARA)[(b)]	Provincial Status[(c)]	CEMA Ratified Indicator[(d)]	Observed[(e)]	Habitat Requirements[(f)]
Artiodactyla							
moose	*Alces alces*	-	-	Secure	yes	yes	mixedwood, around edges of lakes, bogs and streams
woodland caribou	*Rangifer tarandus caribou*	Threatened	Schedule 1: Threatened	At Risk	yes	yes	black spruce bogs and fens, upland jack pine forest
wood bison	*Bos bison athabascae*	Threatened	Schedule 1: Threatened	At Risk	-	no	boreal prairies
Amphibians and Reptiles							
Anura							
Canadian toad	*Anaxyrus hemiophrys*	Not At Risk	-	May Be at Risk	-	no	margins of ponds, lakes and potholes
northern leopard frog	*Lithobates pipiens*	Special Concern	Schedule 1: Special Concern	At Risk	-	no	permanent ponds with emergent vegetation (cattails, bulrushes)
western toad	*Anaxyrus boreas*	Special Concern	Schedule 1: Special Concern	Sensitive	-	yes	ponds, streams or lakes; breeding ponds tend to be shallow with cool water (less than 10ºC) and sandy bottoms
red-sided garter snake	*Thamnophis sirtalis*	-	-	Sensitive	-	no	marshy areas; in winter, hibernates in crevices and caves
Birds							
Podicipediformes							
pied-billed grebe	*Podilymbus podiceps*	-	-	Sensitive	-	yes	pond, wetlands or prairie slough with shoreline or islands dense with emergent growth
horned grebe	*Podiceps auritus*	Special Concern	No Schedule: No Status	Sensitive	-	yes	open and forested areas, preferring ponds, sloughs and lakes with extensive marshy vegetation
western grebe	*Aechmophorus occidentalis*	-	-	Sensitive	-	no	large lakes with large amounts of emergent and floating vegetation

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[a]	Federal Status (SARA)[b]	Provincial Status[c]	CEMA Ratified Indicator[d]	Observed[e]	Habitat Requirements[f]
Pelecaniformes							
American bittern	*Botaurus lentiginosus*	-	-	Sensitive	-	yes	marshes, swamps, moist meadows, wet alder or willow thickets; occasionally in drier meadows, but always in areas with dense growth of vegetation
American white pelican	*Pelecanus erythrorhynchos*	Not At Risk	-	Sensitive	-	no	shallow, turbid lake remote from human activity with extensive shallow waters near shore and good forage and non-sport fish populations (e.g., suckers, sticklebacks)
great blue heron	*Ardea herodias*	-	-	Sensitive	-	yes	areas with shallow, open water, swamps and mudflats
Anseriformes							
trumpeter swan	*Cygnus buccinator*	Not At Risk	-	At Risk	-	no	small to medium size shallow lakes with well-developed emergent and sub-emergent plant communities
white-winged scoter	*Melanitta fusca*	-	-	Sensitive	-	no	near ponds, lakes, oxbows and sluggish streams in treeless or open country, with dense and low ground cover associated; undisturbed islands in deep water lakes
American green-winged teal	*Anas crecca*	-	-	Sensitive	-	yes	wetlands, beaver ponds, lakes
lesser scaup	*Aythya affinis*	-		Sensitive	–	no	wetlands, beaver ponds, lakes
northern pintail	*Anas acuta*	-	-	Sensitive	-	no	wetlands, beaver ponds, lakes

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[(a)]	Federal Status (SARA)[(b)]	Provincial Status[(c)]	CEMA Ratified Indicator[(d)]	Observed[(e)]	Habitat Requirements[(f)]
Accipitriformes							
osprey	*Pandion haliaetus*	-	-	Sensitive	-	yes	permanent lakes and rivers, where there is an adequate supply of fish
bald eagle	*Haliaeetus leucocephalus*	Not At Risk	-	Sensitive	-	yes	proximity of a large body of water, usually an inland lake or river; breeding areas must have suitable tall trees near shore for nesting and roosting, good fish populations
northern goshawk	*Accipiter gentilis*	Not At Risk	-	Sensitive	-	yes	forested habitats, usually in mature forests that are dense; sometimes in areas interspersed with clearings
northern harrier	*Circus cyaneus*	Not At Risk	-	Sensitive	-	yes	open country, including marshes, meadows and cultivated fields
broad-winged hawk	*Buteo platypterus*	-	-	Sensitive	-	no	in woodlands, generally near forest edge at clearings and wet areas
golden eagle	*Aquila chrysaetos*	Not At Risk	-	Sensitive	-	no	rocky outcrops, sparsely wooded slopes and grassland habitats with coulees, steep river banks and canyons
Falconiformes							
American kestrel	*Falco sparverius*	-	-	Sensitive	-	yes	semi-open areas for hunting with trees, cliffs or man-made structures for nesting; woodland edges, burns, meadows, and transmission line right of ways.
peregrine falcon	*Falco peregrinus*	Special Concern	No Schedule: No Status	At Risk	-	no	cliffs near water for nesting and open fields, swamps and marshes for hunting

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[(a)]	Federal Status (SARA)[(b)]	Provincial Status[(c)]	CEMA Ratified Indicator[(d)]	Observed[(e)]	Habitat Requirements[(f)]
Galliformes							
sharp-tailed grouse	*Tympanuchus phasianellus*	-	-	Sensitive	-	yes	openings created by fire and humans, muskegs and bogs
Gruiformes							
yellow rail	*Coturnicops noveboracensis*	Special Concern	Schedule 1: Special Concern	Undetermined	-	no	graminoid marshes and fens
sora	*Porzana carolina*	-	-	Sensitive	-	yes	wetlands and marshes
sandhill crane	*Grus canadensis*	-	-	Sensitive	-	yes	marshes, bogs adjacent to ponds and large marshes with some open water and tall grasses and rushes
whooping crane	*Grus americana*	Endangered	Schedule 1: Endangered	At Risk	-	no	large, relatively open, marshy areas
Charadriiformes							
Caspian tern	*Sterna caspia*	-	-	Sensitive	-	no	large lakes rich with small fish
black tern	*Chlidonias niger*	Not At Risk	-	Sensitive	-	yes	shallow lakes, marshes, sloughs, ponds and wet meadows, where there are extensive shallows and moderate amounts of emergent vegetation
Forster's tern	*Sterna forsteri*	-	-	Sensitive	-	no	cattail marshes and back waters; small lakes with floating or emergent vegetation
Strigiformes							
barred owl	*Strix varia*	-	-	Sensitive	-	no	mixedwood forests with large deciduous trees, particularly along lakeshores and stream valleys; breeding habitat must have densely foliaged trees for roosting and large trees with suitable cavities for nesting

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[(a)]	Federal Status (SARA)[(b)]	Provincial Status[(c)]	CEMA Ratified Indicator[(d)]	Observed[(e)]	Habitat Requirements[(f)]
great grey owl	*Strix nebulosa*	Not At Risk	-	Sensitive	-	yes	coniferous, deciduous and mixedwood areas, usually near water sources such as muskegs, marshes and wet meadows
northern pygmy owl	*Glaucidium californicum*	-	-	Sensitive	-	no	coniferous, deciduous and mixedwood areas; tolerant of mixed-age forest types; requires natural cavities or those excavated by woodpeckers for nesting
short-eared owl	*Asio flammeus*	Special Concern	Schedule1: Special Concern	May Be at Risk	-	yes	open country, including grassland, grassy or brushy meadows, marshland, pastures and previously forested areas that have been cleared
Caprimulgiformes							
common nighthawk	*Chordeiles minor*	Threatened	Schedule 1: Threatened	Sensitive	-	yes	open or semi-open habitats in a variety of areas; forest clearings, burnt-over areas, gravel pits, barren rock and beaches
Piciformes							
black-backed woodpecker	*Picoides arcticus*	-	-	Sensitive	-	yes	burns, mixed or coniferous forests
pileated woodpecker	*Dryocopus pileatus*	-	-	Sensitive	-	yes	older, mature dense-canopied forest, particularly mixed and deciduous woods with large dead and dying trees for nesting and downed woody material for feeding
Passeriformes							
barn swallow	*Hirundo rustica*	Threatened	-	Sensitive	-	yes	utilizes man-made structures for nesting often close to water

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[a]	Federal Status (SARA)[b]	Provincial Status[c]	CEMA Ratified Indicator[d]	Observed[e]	Habitat Requirements[f]
bay-breasted warbler	*Setophaga castanea*	-	-	Sensitive	-	yes	extensive stands of spruce, also mixed stands of spruce, jack pine and tamarack
blackburnian warbler	*Setophaga fusca*	-	-	Sensitive	-	no	mature coniferous or mixedwood forest with large stands of white spruce
black-throated green warbler	*Setophaga virens*	-	-	Sensitive	-	no	mature coniferous or mixedwood forest with large stands of white spruce
brown creeper	*Certhia americana*	-	-	Sensitive	-	yes	mature mixedwood and coniferous forests
Canada warbler	*Cardellina canadensis*	Threatened	Schedule 1: Threatened	Sensitive	-	yes	mature decidous forest with thick, well-developed understory, thick stands of willow and alder along streams and dense shrubs and bushes in swamps near the forest edge
Cape May warbler	*Setophaga tigrina*	-	-	Sensitive	-	yes	coniferous and mixedwood forests, especially mature white spruce stands
common yellowthroat	*Geothlypis trichas*	-	-	Sensitive	-	yes	marshes, streamside thickets, wet meadows and other wetlands
eastern phoebe	*Sayornis phoebe*	-	-	Sensitive	-	no	woodland and edge habitats near water
great crested flycatcher	*Myiarchus crinitus*	-	-	Sensitive	-	no	deciduous and mixedwood forests near clearings
least flycatcher	*Empidonax minimus*	-	-	Sensitive	-	yes	semi-open, second-growth, and mature deciduous and mixedwood forests
olive-sided flycatcher	*Contopus cooperi*	Threatened	Schedule 1: Threatened	May Be At Risk	-	yes	burns, open coniferous forest, clearings adjacent to lakes, streams and meadows, bogs and swamps dominated by spruce and tamarack

Table B-1 Potential and Observed Wildlife Species of Concern in and Around the Local Study Area (continued)

Species	Scientific Name	Federal Status (COSEWIC)[a]	Federal Status (SARA)[b]	Provincial Status[c]	CEMA Ratified Indicator[d]	Observed[e]	Habitat Requirements[f]
rusty blackbird	*Euphagus carolinus*	Special Concern	Schedule 1: Special Concern	Sensitive	-	yes	beaver ponds, wet bogs and swamps, especially conifer dominated
sedge wren	*Cistothorus plantensis*	Not At Risk	-	Sensitive	-	yes	sedge meadows and grassy fields
western tanager	*Piranga ludoviciana*	-	-	Sensitive	-	yes	open coniferous and mixedwood forests
western wood-pewee	*Contopus sordidulus*	-	-	Sensitive		yes	open woodland and forest edges adjacent to lakes, rivers and wetlands
Bird Communities of Concern							
old growth bird community	n/a	n/a	-	n/a	yes	n/a	n/a
ducks and geese	n/a	n/a	-	n/a	-	n/a	n/a
mixedwood forest bird community	n/a	n/a	-	n/a	-	n/a	n/a

(a) COSEWIC (2012a).

(b) Species at Risk Public Registry (2012).

(c) Alberta ESRD (2011).

(d) CEMA (2006).

(e) Observed during field surveys or incidentally.

(f) Sources: Canadian Natural (2002); Ehrlich et al. (1988); Godfrey (1986); Russell and Bauer (2001); Semenchuk (1992); Smith (1993).

COSEWIC = Committee on the Status of Endangered Wildlife in Canada; ESRD = Environment and Sustainable Resource Development; CEMA = Cumulative Environmental Management Association.

n/a = Not applicable.

- = Indicates that there is currently no federal assessment for the species or that the species is not a CEMA ratified indicator.

ATTACHMENT C

INCIDENTAL WILDLIFE SIGHTINGS

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area

Species	Observations					Provincial Status[b]	Federal Status[c]	Habitat
	Visual	Audio	Other[a]	Unknown	Total			
Birds								
bittern - American	-	1	-	-	**1**	Sensitive	-	unknown
blackbird - red-winged	1	5	-	-	**6**	Secure	-	MONG
blackbird - rusty	4	1	-	-	**5**	Sensitive	Special Concern	BTNN, FONS, FTNN
bluebird - mountain	-	2	-	-	**2**	Secure	-	unknown
bufflehead	7	-	-	-	**7**	Secure	-	WONN
bunting - snow	2	-	-	-	**2**	Secure	-	d3
chickadee - black-capped	1	4	-	-	**5**	Secure	-	c1, g1
chickadee - boreal	1	6	-	-	**7**	Secure	-	BTNN, FTNN, g1
chickadee - mountain	-	1	1	-	**2**	Secure	-	g1, Shrub
coot - American	6	-	-	-	**6**	Secure	Not at Risk	FONG
crane - sandhill	8	7	-	-	**15**	Sensitive	-	d1, FONS, SONS
creeper - brown	-	3	-	-	**3**	Sensitive	-	unknown
crossbill - white-winged	132	1	-	-	**133**	Secure	-	a1, b1, b2, b4, BTNN, BUu, c1, d1, d2, FONS, FTNN, g1
crow- American	4	6	-	-	**10**	Secure	-	BTNN, FTNN, g1
duck - ring-necked	7	2	-	-	**9**	Secure	-	WONN
duck species	4	-	-	-	**4**	n/a	n/a	STNN
finch - purple	-	1	-	-	**1**	Secure	-	unknown
flicker - northern	3	12	-	-	**15**	Secure	-	BUu, FTNN, g1, Shrub
flycatcher - alder	1	73	-	-	**74**	Secure	-	d1, d2, SONS
flycatcher - least	-	5	-	-	**5**	Sensitive	-	unknown
flycatcher - olive-sided	1	14	-	-	**15**	May be at Risk	Threatened	BUu, BUw, c1, g1, Me
flycatcher - yellow-bellied	-	2	-	-	**2**	Undetermined	-	unknown
goldeneye - Barrow's	4	-	-	-	**4**	Secure	-	SONS
goose - Canada	31	3	-	-	**34**	Secure	-	d2, FTNN, MONG
goose - snow	120	-	-	-	**120**	Secure	-	unknown
goshawk - northern	4	-	-	-	**4**	Sensitive	Not at Risk	BUu, c1, FONS
grebe- pied-billed	-	1	-	-	**1**	Sensitive	-	unknown
grebe - red-necked	-	3	-	1	**4**	Secure	Not at Risk	WONN
grosbeak - evening	-	1	-	-	**1**	Secure	-	unknown
grosbeak - rose-breasted	-	1	-	-	**1**	Secure	-	unknown

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area (continued)

Species	Observations					Provincial Status[b]	Federal Status[c]	Habitat
	Visual	Audio	Other[a]	Unknown	Total			
grouse - ruffed	2	21	-	1	**24**	Secure	-	b1, b3, BTNN, BU, d1, d2, d3, DIS, f2, g1, MONG, STNN
grouse - sharp-tailed	54	-	-	-	**54**	Sensitive	-	a1, BUw, c1, DIS, FTNN
grouse - spruce	8	7	-	-	**15**	Secure	-	b1, c1
grouse spp.	1	1	6	-	**8**	n/a	n/a	b1, c1, g1, Shrub
gull - Bonaparte's	4	8	-	-	**12**	Secure	-	BTNN, c1, FONS, FTNN
gull- herring	1	-	-	-	**1**	Secure	-	BTNN
gull - ring-billed	-	-	-	1	**1**	Secure	-	unknown
harrier - northern	15	-	-	-	**15**	Sensitive	Not at Risk	BUw, c1, DIS, FONG, FONS, FTNN, Lake, SONS
hawk - red-tailed	1	-	-	-	**1**	Secure	Not at Risk	FTNN
hawk - rough-legged	3	-	-	-	**3**	Secure	Not at Risk	BUu, FONG, FTNN
hawk - Swainson's	-	2	-	-	**2**	Sensitive	-	STNN
hawk species	1	-	-	-	**1**	n/a	n/a	FTNN
heron - great blue	2	-	-	-	**2**	Sensitive	-	BU, DIS-L
jay - gray	13	100	-	3	**116**	Secure	-	a1, BTNN, c1, d1, d2, FONS, FTNN, g1, SONS, WONN
junco - dark-eyed	1	60	-	-	**61**	Secure	-	d2
kestrel - American	1	-	-	-	**1**	Sensitive	-	BTNN
killdeer	2	4	-	-	**6**	Secure	-	c1, FTNN, Lake, STNN
kingfisher - belted	2	1	-	-	**3**	Secure	-	SONS
kinglet - ruby-crowned	2	68	-	2	**72**	Secure	-	d2, FTNN, g1, MONG, SONS
lark, horned	1	-	-	-	**1**	Secure	-	BUw
longspur, lapland	7	-	-	-	**7**	Secure	-	DIS-l
loon - common	21	40	-	1	**62**	Secure	Not at Risk	b4, BTNN, BU, c1, FONG, FONS, FTNN, Lake, MONG, SONS, STNN, WONN
magpie - black-billed	1	-	-	-	**1**	Secure	-	FONG
mallard	109	-	-	-	**109**	Secure	-	WONN
merganser-common	2	-	-	-	**2**	Secure	-	WONN
merlin	1	-	-	-	**1**	Secure	Not at Risk	b3
nighthawk - common	8	14	-	-	**22**	Sensitive	Threatened	a1, BTNN, BUu, BUw, c1, DIS, FONS, FTNN, g1, Shrub

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area (continued)

Species	Observations					Provincial Status(b)	Federal Status(c)	Habitat
	Visual	Audio	Other(a)	Unknown	Total			
nuthatch - red-breasted	-	12	-	-	**12**	Secure	-	unknown
nuthatch - white-breasted	-	1	-	-	**1**	Secure	-	unknown
osprey	1	-	-	-	**1**	Sensitive	-	BU
ovenbird	-	28	-	-	**28**	Secure	-	unknown
owl - boreal	-	2	-	-	**2**	Secure	Not at Risk	c1, FTNN
owl - great grey	4	1	-	-	**5**	Sensitive	Not at Risk	b2, BUw, c1, FONS
owl - great horned	1	2	-	-	**3**	Secure	-	FONG
owl - northern hawk	-	2	-	-	**2**	Secure	Not at Risk	BUu
owl - short-eared	1	-	-	-	**1**	May be at Risk	Special Concern	SONS
owl species	1	-	-	-	**1**	n/a	n/a	FTNN
pipit - American	20	-	-	-	**20**	Secure	-	DIS-l
raptor spp.	2	-	-	-	**2**	n/a	n/a	BTNN
raven - common	13	19	-	-	**32**	Secure	-	b1, c1, d1,DIS, FTNN, g1, Shrub
redstart - American	-	4	-	-	**4**	Secure	-	unknown
robin - American	-	16	-	5	**21**	Secure	-	b4, FONS, FTNN
sandpiper - least	-	1	-	-	**1**	Secure	-	unknown
sandpiper - solitary	4	10	-	-	**14**	Secure	-	BTNN, c1, FONS, FTNN, g1, SONS
sandpiper - spotted	-	1	-	-	**1**	Secure	-	unknown
sapsucker - yellow-bellied	1	1	-	-	**2**	Secure	-	BTNN
scoter - surf	5	-	-	-	**5**	Secure	-	WONN
siskin - pine	49	4	-	-	**53**	Secure	-	a1, b1, BTNN, BUu, c1, d2, d3, FONS, FTNN, g1, Shrub, SONS
snipe - Wilson's	12	46	-	1	**59**	Secure	-	BUw, c1, d1, d2, FONG, FONS, FTNN, g1, MONG, Shrub, SONS, STNN, WONN
sora	1	2	-	-	**3**	Sensitive	-	FTNN
sparrow - chipping	1	88	-	-	**89**	Secure	-	SONS
sparrow - clay-coloured	-	12	-	-	**12**	Secure	-	unknown
sparrow - Le Conte's	-	5	-	-	**5**	Secure	-	BTNN
sparrow - Lincoln's	-	28	-	-	**28**	Secure	-	unknown
sparrow - swamp	-	18	-	-	**18**	Secure	-	unknown
sparrow - white-throated	2	59	-	-	**61**	Secure	-	c1, d2, DIS, FONS, MONG, SONS, STNN

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area (continued)

Species	Observations					Provincial Status[b]	Federal Status[c]	Habitat
	Visual	Audio	Other[a]	Unknown	Total			
swallow - bank	-	1	-	-	**1**	Secure	-	SONS
swallow - barn	2	-	-	-	**2**	Sensitive	Threatened	WONN
swallow - tree	15	-	-	-	**15**	Secure	-	BUu, BUw, FONG, FTNN, g1, MONG, Riparian, Shrub, WONN
tanager - western	-	2	-	-	**2**	Sensitive	-	unknown
teal - blue-winged	11	-	-	-	**11**	Secure	-	STNN
teal - green-winged	4	1	-	-	**5**	Sensitive	-	c1
tern - black	10	-	-	-	**10**	Sensitive	Not at Risk	FONS, FTNN
thrush - hermit	-	68	-	-	**68**	Secure	-	unknown
thrush - Swainson's	-	45	-	-	**45**	Secure	-	unknown
vireo - blue-headed	-	7	-	-	**7**	Secure	-	unknown
vireo - red-eyed	-	22	-	-	**22**	Secure	-	unknown
warbler - bay-breasted	-	2	-	-	**2**	Sensitive	-	unknown
warbler - black-and-white	-	1	-	-	**1**	Secure	-	unknown
warbler - Canada	-	1	-	-	**1**	Sensitive	Threatened	FTNN
warbler - Cape May	-	1	-	-	**1**	Sensitive	-	unknown
warbler - Connecticut	-	4	-	-	**4**	Secure	-	unknown
warbler - magnolia	-	3	-	-	**3**	Secure	-	unknown
warbler - mourning	-	7	-	-	**7**	Secure	-	unknown
warbler - Nashville	-	5	-	-	**5**	Secure	-	BUu, g1
warbler - orange-crowned	-	6	-	-	**6**	Secure	-	unknown
warbler - palm	-	21	-	-	**21**	Secure	-	unknown
warbler - Tennessee	-	43	-	-	**43**	Secure	-	d1
warbler - Wilson's	-	2	-	-	**2**	Secure	-	unknown
warbler - yellow	-	1	-	-	**1**	Secure	-	unknown
warbler - yellow-rumped	1	73	-	-	**74**	Secure	-	g1
waterthursh - northern	-	2	-	-	**2**	Secure	-	unknown
waxwing - cedar	16	-	-	-	**16**	Secure	-	a1, BTNN, BU
wigeon - American	4	-	-	-	**4**	Secure	-	FONG, STNN
woodpecker - black-backed	1	-	-	-	**1**	Sensitive	-	CC
woodpecker - hairy	1	4	-	-	**5**	Secure	-	d2, d3, FONS, STNN
woodpecker - pileated	3	4	4	-	**11**	Sensitive	-	c1, d1, FTNN

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area (continued)

Species	Observations					Provincial Status[b]	Federal Status[c]	Habitat
	Visual	Audio	Other[a]	Unknown	Total			
woodpecker spp.	2	8	-	-	**10**	n/a	n/a	b3, FONG
wood-pewee - western	-	3	-	-	**3**	Sensitive	-	unknown
wren - winter	-	10	-	-	**10**	Secure	-	unknown
yellowlegs - greater	6	27	-	2	**35**	Secure	-	FONG, FONS, FTNN, g1, Lake, SONS
yellowlegs - lesser	2	14	-	-	**16**	Secure	-	c1, FONG, FONS, FTNN
yellowlegs species	2	1	-	-	**3**	n/a	n/a	MONG
yellowthroat - common	-	13	-	-	**13**	Sensitive	-	unknown
Mammals								
bat - little brown	1	-	-	-	**1**	Secure	-	FTNN
bear - black	2	1	12	-	**15**	Secure	Not at Risk	b3, BTNN, c1, d1, d2, DIS, g1, DIS-L
beaver	25	3	11	-	**39**	Secure	-	c1, FONG, FTNN, Lake, MONG, Pond, SONS, WONN
caribou - woodland	19	-	114	-	**133**	At Risk	Threatened	a1, BTNN, BU, c1, CC, CL, DIS, e1, FONG, FONS, FTNI, FTNN, g1, Lake, MONG, SONS, DIS-L, WONN
coyote	1	1	5	-	**7**	Secure	-	BU, DIS, d2, DIS-l, g1
deer - white-tailed	2	-	-	-	**2**	Secure	-	a1, DIS
deer spp.	1	-	12	-	**13**	n/a	n/a	a1, c1, d1, d2, FTNN, g1, SONS
fisher	3	-	-	-	**3**	Sensitive	-	c1, WONN
fisher/marten	-	-	4	-	**4**	Secure	-	d3, g1
hare - snowshoe	5	-	25	-	**30**	Secure	-	a1, c1, d2, FONG, FTNN, g1
lynx - Canada	2	-	12	-	**14**	Sensitive	Not at Risk	a1, b2, BU, c1, CC, d2, DIS, FTNN, g1
moose	21	1	49	-	**71**	Secure	-	b3, BTNN, BU, c1, CC, CL, d1, d2, d3, DIS, FONG, FTNN, g1, DIS-L, STNN, WONN
mouse species	-	-	1	-	**1**	n/a	n/a	c1
muskrat	6	-	1	-	**7**	Secure	-	BTNN, c1, MONG
otter - river	3	-	8	-	**11**	Secure	-	Lake, MONG, SONS, STNN, WONN
squirrel - red	4	4	16	1	**25**	Secure	-	a1, b4, c1, d1, d2, FTNN, g1, STNN
weasel spp.	-	-	3	-	**3**	n/a	n/a	c1, d1, g1
wolf - grey	17	24	40	-	**81**	Secure	Not at Risk	a1, burn, BTNN, c1, CL, d1, d2, DIS, DIS-l, FONS, FTNN, g1, Lake, MONG, WONN

Table C-1 Incidental Wildlife Sightings in and Around the Local Study Area (continued)

Species	Observations					Provincial Status[b]	Federal Status[c]	Habitat
	Visual	Audio	Other[a]	Unknown	Total			
Amphibians								
frog - boreal chorus	-	310	-	-	**310**	Secure	-	b1,c1, DIS, FTNN, g1, SONS
frog - wood	25	203	-	3	**231**	Secure	-	a1, BTNN, BUu, BUw, c1, DIS, FTNN, g1, SONS
toad - western	9	19	-	-	**28**	Sensitive	Special Concern	c1, CC, DIS, FONS, FTNN, g1, MONG, SONS, WONN
Total	**947**	**1,809**	**324**	**21**	**3,101**	**n/a**	**n/a**	**n/a**

(a) "Other" refers to sign that includes (but is not restricted to) tracks, scat, markings, lodges, dams, feeding activity, bedding, nests, and kill sites.

(b) Alberta ESRD (2011).

(c) COSEWIC (2012a); Species at Risk Public Registry (2012).

- = Indicates that there is currently no federal assessment for the species or that there is no habitat association for that observation.

n/a = Not applicable.

unknown = Animal was heard nearby, but in an unknown habitat.

ATTACHMENT D

WINTER TRACK COUNT RESULTS

Table D-1 Number of Tracks per Kilometre-day Observed for Each Wildlife Species by Land Cover Type in and Around the Local Study Area

Land Cover Type[(a)]		Track Days [km/day]	Species Tracks per Kilometre per Day																Total Tracks per Land Cover Type
			CALY	COYO	DESP	FIMA	GROU	GRWO	MICE	MOOS	PORC	PTAR	REFO	RESQ	RIOT	SNHA	WESP	WOCA	
Ecosite Phase																			
a1	lichen jack pine	3.36	0.00	0.00	0.60	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	19.93	0.00	36.89	0.00	0.00	58.32
b1	blueberry jackpine-aspen	2.56	0.00	1.17	1.17	0.39	0.78	0.00	1.56	0.00	0.00	0.00	0.00	4.69	0.00	132.94	0.00	0.00	142.72
b2	blueberry aspen (white birch)	0.90	0.00	3.32	0.00	0.00	0.00	3.32	2.21	0.00	0.00	0.00	0.00	6.64	0.00	106.25	0.00	0.00	121.75
b3	blueberry aspen-white spruce	2.62	0.38	0.38	0.00	0.38	0.38	0.00	0.00	1.91	0.00	0.00	0.00	2.29	0.00	45.74	0.00	0.00	51.46
b4	blueberry white spruce-jack pine	3.99	0.50	0.00	2.26	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	10.27	0.00	48.11	0.00	0.00	61.40
c1	Labrador tea mesic jack pine-black spruce	15.33	0.65	0.46	0.00	0.20	0.46	0.00	0.26	0.52	0.07	0.00	0.07	9.46	0.00	79.67	0.13	0.00	91.93
d1	low-bush cranberry aspen	6.13	0.33	0.65	0.00	0.16	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.00	37.22	0.00	0.00	39.51
d2	low-bush cranberry aspen-white spruce	8.02	0.12	1.25	0.00	0.12	0.37	0.25	1.50	1.25	0.00	0.00	0.00	8.10	0.00	58.59	0.37	0.00	71.92
d3	low-bush cranberry white spruce	0.40	0.00	2.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.26	0.00	148.80	0.00	0.00	181.59
e2	dogwood balsam poplar-white spruce	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	191.92	0.00	0.00	191.92
f1	horsetail balsam poplar-aspen	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
g1	Labrador tea-subhygric black spruce-jack pine	60.38	0.53	0.30	0.07	0.12	0.73	0.02	0.35	0.00	0.00	0.00	0.00	6.41	0.00	92.98	0.28	0.05	101.83
h1	Labrador tea/horsetail white spruce-black spruce	0.75	1.34	0.00	2.68	2.68	4.02	0.00	0.00	0.00	0.00	0.00	1.34	25.44	0.00	247.66	0.00	0.00	285.14
Wetlands Type																			
BONS	shrubby bog	3.39	0.00	0.00	0.59	0.00	0.00	0.00	0.30	0.00	0.00	20.97	0.00	2.36	0.00	4.13	0.59	0.00	28.94
BTNN	wooded bog	26.66	1.13	0.08	0.04	0.26	0.34	0.00	0.23	0.08	0.00	0.00	0.00	4.09	0.00	47.26	0.83	0.19	54.50
FONG	graminoid fen	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FONS	shrubby fen	13.66	0.15	0.22	0.00	0.15	0.00	0.29	0.07	0.00	0.00	1.54	0.00	0.07	0.00	17.57	0.66	0.15	20.86
FTNN	wooded fen	41.14	0.15	0.02	0.15	0.02	0.19	0.07	0.22	0.10	0.00	0.00	0.00	2.09	0.00	48.67	0.29	0.05	52.02
MONG	graminoid marsh	1.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.85	0.00	0.00	52.85
SONS	shrubby swamp	3.67	0.00	0.82	0.27	0.00	0.00	0.00	1.09	0.00	0.00	0.00	0.00	2.18	0.00	55.56	0.54	0.00	60.46
STNN	wooded swamp	3.31	0.61	0.00	1.82	0.30	0.30	0.61	0.00	2.72	0.00	0.00	0.00	1.51	0.00	52.03	0.30	0.00	60.20
Other																			
Burn	burn	24.47	0.45	0.33	0.12	0.00	0.12	0.00	0.20	0.00	0.00	0.00	0.00	1.14	0.00	32.17	0.45	0.00	34.99
DIS-l	disturbed – linear[(b)]	8.50	1.65	1.65	0.24	0.12	0.00	1.29	0.82	0.59	0.00	0.00	0.00	3.65	0.00	25.89	0.24	0.12	36.25
DIS-nl	disturbed – non-linear[(c)]	1.63	0.00	0.00	0.00	0.00	0.00	0.00	2.45	0.00	0.00	0.00	0.00	0.00	0.00	2.45	0.00	0.00	4.91
Ice	ice	1.38	0.00	0.00	0.00	0.00	0.00	0.00	12.35	0.00	0.00	0.00	0.00	0.00	0.73	0.73	0.00	0.00	13.80
Shrub	shrubland	80.89	0.07	0.09	0.01	0.20	0.73	0.01	0.15	0.26	0.00	0.00	0.00	0.56	0.00	4.78	0.42	0.07	7.36
Overall tracks per species[(d)]		**315.16**	**0.38**	**0.27**	**0.13**	**0.14**	**0.46**	**0.09**	**0.35**	**0.20**	**<0.01**	**0.29**	**0.01**	**3.45**	**<0.01**	**44.68**	**0.37**	**0.06**	**50.88**

(a) Beckingham and Archibald (1996) and Halsey et al. (2003).

(b) Disturbed – linear types include seismic lines, cutlines and roads.

(c) Disturbed – non-linear types include well pads and clearcuts.

(d) The values in this row reflect the sum of the absolute track counts per species divided by the total track days. The values do not reflect the sum of the values shown in each column.

Note: CALY = Canada lynx, COYO = coyote, DESP = deer species, FIMA = fisher/marten, GROU = grouse species, GRWO = gray wolf, MICE = mice species, MOOS = moose, PORC = porcupine, PTAR = ptarmigan, REFO = red fox, RESQ = red squirrel, RIOT = river otter, SNHA= snowshoe hare, WESP = weasel species, WOCA = woodland caribou.

ATTACHMENT E

HISTORIC WILDLIFE SURVEY RESULTS IN THE REGION

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Table E-1 Moose Aerial Survey Results Within the Region

Year	Project	Results [Individuals/km² unless otherwise noted]	Habitat	Reference
1969 to 1985	Alberta Environment	0.21 to 0.54	n/a	Gunderson and Rippin (1981), cited in BP Resources et al. (1985)
1973	Alberta Environment	0.50	n/a	Bibaud and Archer (1973)
1975 to 1976	Syncrude Lease 17	0.23	preferred tall shrub, deciduous and avoided mixedwood in early winter; preferred tall shrub and avoided coniferous in late winter	Penner (1976)
1977	AOSERP[(a)]	0.03 in muskeg 0.23 in aspen 0.27 in river bottom	n/a	Cook and Jacobsen (1978)
1977 to 1978	AOSERP	0.26 in March 0.28 in December 0.19 in February	n/a	Hauge and Keith (1981), as reported in Conor Pacific (1998)
1978	Syncrude	0.10	n/a	Hauge and Keith (1981)
1978 to 1979	Esso	0.14 to 0.18	n/a	Esso (1979)
1978 to 1981	Alberta Environment	0.25 to 0.34	n/a	Gunderson and Rippin (1981), cited in BP Resources (1985)
1979 to 1980	Syncrude	0.13 in December 0.23 in February	December most in mixedwood, black spruce-muskeg and shrub February most in deciduous and mixedwood	Westworth (1980)
1980	Canstar Project 80	0.10 in December	most in riparian shrub and black spruce-muskeg	Skinner and Westworth (1981)
1981	Dome Petroleum Ltd.	0.17	n/a	Roe (1984), cited in Suncor (1995)
1981 to 1982	Canstar Lease	0.33 in early winter 0.32 in late winter	most in mixedwood, aspen and willow wetlands in early winter most in willow wetlands, mixedwood, black spruce and aspen in late winter	Westworth and Brusnyk (1982)
1983	AOSTRA	0.18 in February	n/a	Green (1980), as reported in Conor Pacific (1998)
1985	Alberta Environment	0.52	n/a	Penner and Ealey, cited in Suncor (1995)
1986	OSLO[(b)]	0.11 in early winter 0.07 in late winter	n/a	Salter et al. (1986)
1991	Esso Resources Ltd.	0.14	n/a	Brusnyk et al. (1991), cited in Esso (1997)
1992 to 1993	Alberta Environment	0.10	n/a	AENV, Fish and Wildlife Division, cited in Esso (1997)

Table E-1 Moose Aerial Survey Results Within the Region (continued)

Year	Project	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
1995	Solv-Ex	0.01 in March	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.10 in January	most in black spruce-tamarack	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.20 in February 0.32 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February; avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996c)
1996	Steepbank Study Area	0.24 in February 0.24 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996b)
1998	Suncor Firebag Project	0.2 in February	most in FTNN	Suncor (2000)
1999	Mobil Lease 36	0.22 in February	most in FONS, FTNN and FT/STNN	Golder (1999b)
1999 to 2000	Petro-Canada MacKay River	0.37 in December 0.17 in February	found mostly in d1	AXYS (2000a)
2000	Canadian Natural Primrose and Wolf Lake (PAW) Project	0.07	n/a	Canadian Natural (2000)
2000	PanCanadian Christina Lake Thermal Project Study Area	0.04 in late winter	three in BTNN and two in FTNN	Golder (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.22 in mid winter 0.25 in late winter	only in d1, b1 and disturbed in mid winter most in d1 and d2 in late winter	Golder (2000a)
2000	OPTI Long Lake Project	0.20 in January 0.28 in March	most observations in FTNN and BTNN	OPTI (2000)
2001	Rio Alto Kirby Project	0.08 in February	two moose observed in FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.21 in February	most observations in FTNN, d2 and e1	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.21	most observations in FTNN, h1, SONS and d2	Golder (2002a)
2001	Canadian Natural Horizon Project	0.15	most observations in d1, d2 and e1	Canadian Natural (2002)

Table E-1 Moose Aerial Survey Results Within the Region (continued)

Year	Project	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
2002	Petro-Canada Meadow Creek Aerial Ungulate Survey	0.10 in February	observed in BTNN, SONS, FTNN, d1, d2 and d3 ecosite phases/wetlands types	Golder (2002b)
2003	Petro-Canada Meadow Creek Aerial Caribou Survey	0.13 in February	observed in d3, g1, BTNN, SONS, and WONN ecosite phase/wetlands types	Golder (2003a)
2002	Suncor South Tailings Pond Project	0.1	observed in b3 and FTNN	Golder (2003b)
2002	Devon Jackfish Project	0.16	most observations in closed aspen forest	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	0.09	observed in d2 and FONS	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.07	observed within d1, d2, BTNN and FONS	MEG (2005)
2004	Suncor Voyageur	0.10 0.05	observed in b3 observed in FTNN	Suncor (2005)
2004 to 2005	Primrose East Expansion	0.05	observed in d1, d2, BTNN, and FONS	Canadian Natural (2006)
2006	Devon Jackfish 2 Project	0.16	observed in burn area, aspen forest, mixedwood forest, treed bog, treed fen, tall shrub, and open jack pine forest	Devon (2006)
2006 to 2007	Suncor Voyageur South	0.25	observed in d1, d2, d3, e3, BTNN, FONS, FTNN, cutblocks, BTNN, FONS	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.06	observed in FTNN, FONS	EnCana (2009)
2007	Canadian Natural Kirby Project	no observations	n/a	Canadian Natural (2007)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine – 0.22 Pierre River – no observations	observed in BUu, BTNN, CC, d1, d2, FTNN, FONG n/a	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	0.03	observed in d2, BTNN, FTNN	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	0.02	d1, d2, and FTNN	MEG (2008)
2008	Total Joslyn Mine Expansion	0.16	d1, d2, d2-dist, and disturbed transmission line	Unpublished Data
2008	Enerplus Kirby Project	0.46	observed in b1, d1, d2, STNN, SONS, BUu, BUw, meadow, and cutblock	Enerplus (2008)

Table E-1 Moose Aerial Survey Results Within the Region (continued)

Year	Project	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
2008	Cenovus Narrows Lake Project	1 individual	not determined	Cenovus (2010)
2008	West Ells SAGD Project	No observations	n/a	Sunshine (2010)
2009	STP McKay SAGD Pilot Project	No observations	n/a	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	0.038	primarily in wetlands and disturbed sites	Dover OPCO (2010)
2007 and 2011	CPC Surmont Project	0.12 for both years	majority in d1 and d2 and disturbed sites	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.09	primarily in FTNN	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	0.08	observed in burned areas	Canadian Natural (2011)

(a) AOSERP = Alberta Oil Sands Environmental Research Program.

(b) OSLO = Other Six Lease Owners.

n/a = Not applicable.

Table E-2 Moose Productivity in the Region

Year	Project	Cow:Calf Ratio	Reference
1975 to 1976	Syncrude Lease 17	10:5.6	Penner (1976)
1979 to 1980	Syncrude	10:6.2 in December; 10:4.3 in February	Westworth (1980)
1980	Canstar Project 80	10:3 in December	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	10:3.0 in early winter; 10:3.2 in late winter	Westworth and Brusnyk (1982)
1995	Syncrude Aurora North	10:7.1 in January	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	10:8.3 in February; 10:6.4 in December	Westworth, Brusnyk and Associates (1996c)
1996	Steepbank Study Area	10:4.3 in February; 10:3.5 in December	Westworth, Brusnyk and Associates (1996b)
1999	Mobil Lease 36	10:1.7	Golder (1999b)
1999 to 2000	Petro-Canada MacKay River	10:6.3 in December; 10:7.8 in February	AXYS (2000a)
2000	TrueNorth Fort Hills Oil Sands Project	10:10	Golder (2000a)
2000	OPTI Long Lake Project	10:8	OPTI (2000)
2001	Petro-Canada Meadow Creek Project	10:5	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	10:1.1	Golder (2002a)
2001	Canadian Natural Horizon Project	10:3.5	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Ungulate Aerial Survey	10:6.7	Golder (2002b)
2003	Petro-Canada Meadow Creek Caribou Aerial Survey	10:7.5	Golder (2003a)
2002	Suncor South Tailings Pond Project	10:5	Golder (2003c)
2002	Devon Jackfish Project	10:6.4	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	10:2.5	Golder (2004a)
2004	MEG Christina Lake Regional Project	10:2.5	MEG (2005)
2004	Suncor Voyageur	n/a	Golder (2005)
2004 to 2005	Primrose East Expansion	10:5	Canadian Natural (2006)
2006	Devon Jackfish 2 Project	10:4	Devon (2006)
2006 to 2007	Suncor Voyageur South	10:5	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	10:10	EnCana (2009)
2007	Canadian Natural Kirby	n/a	Canadian Natural (2007)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	10:10	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	10:10	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	too few to calculate	MEG (2008)
2008	Total Joslyn Mine Expansion	not determined	Unpublished Data

Table E-2 Moose Productivity in the Region (continued)

Year	Project	Cow:Calf Ratio	Reference
2008	Enerplus Kirby Project	10:6.7	Enerplus (2008)
2008	Cenovus Narrows Lake Project	10:7.5	Cenovus (2010)
2008	West Ells SAGD Project	not determined	Sunshine (2010)
2009	McKay SAGD Pilot Project	not determined	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	10:1.3	Dover OPCO (2010)
2007 and 2011	CPC Surmont Project	10:6 in both years	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	10:9	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	10:8.8	Canadian Natural (2011)

n/a = Not applicable.

Table E-3 Moose Track Count Survey Results Within the Region

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	0.14	preferred tall shrub; avoided coniferous and disturbed areas	Penner (1976)
1980	Canstar Project 80	0.63	preferred riparian shrub; avoided jack pine and open muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.33	preferred willow and riparian aspen; avoided jack pine, white spruce, black spruce and riparian white spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.11	preferred cleared aspen; avoided mixedwood forest, willow wetlands riparian balsam poplar, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.22 in February 0.65 in December	February: avoided jack pine, white spruce, mixed coniferous mixedwood, shorelines and fen December: avoided closed black spruce and open tamarack fen	Westworth, Brusnyk and Associates (1996c)
1997	Muskeg River Mine	0.26	no preference most tracks observed in closed mixedwood-white spruce dominant	Golder (1997a,b)
1997	Suncor	0.29 in January 0.30 in February 0.19 in March	January: avoided upland February: preferred riparian, avoided escarpment March: no preference	Golder (1998a,b)
1997	Suncor	0.03 in January 0.0 in February	January: no preference February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	0.32	most observations in black spruce –tamarack and tamarack black spruce bogs and fens	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.41	preferred BTNN, BFNN, FONS and FTNN/FFNN avoided b4, c1, d3 and g1	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.0 in reclaimed 0.46 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 2.0	most common in cutblock, also common in FONS, d1 and d2	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.37	preferred e1; avoided d2, g1, BTNN and FTNN	Golder (2000a)
2000	Albian Sands Lease 13 West	0.56 in upland 0.60 in riparian	vegetation preferences not available due to lumping by landform	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 1.68 in Lease 25/97	only riparian corridors sampled	Golder (2000d)

Table E-3 Moose Track Count Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
2000	OPTI Long Lake Project	0.25	no preference most tracks observed in the d2 and FTNN ecosite phase/wetlands types	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	0.5	highest track densities in e2; also observed in b2, c1, d1, d2, e3, f1, g1, BTNN, FTNN, FONS and FONG	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.56 in January 1999/2000 0.21 in January 2000/2001 0.16 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.57 in February	No preference; most tracks observed in d2 and c1 ecosite/wetlands types, but also observed in b3 and cutlines	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.52	tracks observed in c1, e1, BTNN, STNN; preference observed for BTNN, avoidance of FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.47	tracks observed in b4, FTNN, g1 and shrubland	Golder (2002a)
2001	Canadian Natural Horizon Project	0.16	tracks observed in d2, d3, cutblock and burn; preference observed for burn, avoidance of d3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.72	tracks observed in FONS, FONG, and d2	Golder (2003b)
2002	Devon Jackfish Project	0.26	highest track density in e1	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	no fresh tracks observed	old track observed in riparian creek area	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.34	no preferences determined, tracks observed within SONS, d1, d2 and FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.59	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	0.45 0.70	preference for deciduous forests observed in b3, d1, d2, d3, and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	0.22	observed in d1, disturbed-cutline, FONS, FTNN, and STNN; most in d1	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	0.49	most trails observed in burn area and closed riparian shrubland	Devon (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in e3	OPTI/Nexen (2006)
2005 to 2007	Suncor Voyageur South	0.68	preference for b3, d1	Suncor (2007)

Table E-3 Moose Track Count Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.25	avoidance FTNN	EnCana (2009)
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 4.27 Pierre River - 0.34	preference for b3, d1, e1, and FONS communities used a1, b1, e3, g1 ecosite phases and BTNN and FTNN wetlands communities less than expected	Shell (2007)
2007	StatoilHydro Canada Ltd. Kai Kos Dehseh	0.2	most observed in d2	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	0.23	observed in d1, d2, FTNN, and SONS	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	0.22	preference for b3, e1, d1	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	0.86	highest track density observed in k2 and k1	Unpublished Data
2008	Enerplus Kirby Project	0.29	BTNN, FTNN, STNN, and shrub wetlands	Enerplus (2008)
2009 to 2010	Cenovus Narrows Lake Project	0.01	SONS	Cenovus (2010)
2008	West Ells SAGD Project	1.0	Highest track densities observed in lowland shrub	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0	n/a	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	0.08	most tracks observed in FTNN and BTNN; highest track density in FONS	Dover OPCO (2010)
2011	CPC Surmont Project	0.28	highest track densities observed in e3, b2, STNN and on linear disturbance	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.24	most tracks observed in d2 and e1	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.20	highest track densities observed in STNN and b3	Present Study

n/a = Not applicable.

Table E-4 Moose Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate[a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	no observations	Suncor (2007)
		Winter	0.10	
		Spring	0.10	
		Summer	0.20	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter	0.08	
		Spring	0.17	
		Summer	0.08	
2006 to 2007	Canadian Natural Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter	0.33	
		Spring	0.16	
		Summer	0.20	
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter	no observations	
		Spring	0.38	
		Summer	0.38	
		Pierre River Mine		
		Fall	0.14	
		Winter	no observations	
		Spring	0.19	
		Summer	0.22	
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	no observations	MEG (2008)
		Winter	no observations	
		Spring	0.09	
		Summer	0.18	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	0.40	Suncor (2008)
		Winter	no observations	
		Spring	no observations	
		Summer	0.20	
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.17	Unpublished Data
		Winter	no observations	
		Spring	0.08	
		Summer	0.08	

Table E-4 Moose Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate[(a)]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter	no observations	
		Spring	0.17	
		Summer	no observations	
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter	no observations	
		Spring	0.07	
		Summer	no observations	
2008 to 2010	Dover Commercial Project	Fall	0.10	Dover OPCO (2010)
		Winter	no observations	
		Spring	0.05	
		Summer	0.15	
2005	CPC Surmont Project	Fall	0.04	Unpublished Data
		Winter	0.08	
		Spring	0.04	
		Summer	0.08	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	no observations	Cenovus (2011)
		Winter	0.03	
		Spring	no observations	
		Summer	0.20	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter	0.08	
		Spring	0.09	
		Summer	0.04	

(a) Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-5 Deer Aerial Survey Results Within the Region

Year	Project	Species	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	combined	one mule deer observed	Athabasca River	Penner (1976)
1978 to 1979	Esso	combined	0.14	n/a	Esso (1979), as reported in BP Resources et al. (1985)
1980	Canstar Project 80	combined	no observations	n/a	Skinner and Westworth (1981)
1978 to 1981	Alberta Environment	combined	0.28 in 1979 to 0.50 in 1981	n/a	Gunderson and Rippin (1985), as reported in BP Resources et al. (1985)
1981 to 1982	Canstar Lease	mule deer	no observations	n/a	Westworth and Brusnyk (1982)
1981 to 1982	Canstar Lease	white-tailed deer	0.01 in early winter no observations in late winter	in mixedwood, white spruce and aspen not available for late winter	Westworth and Brusnyk (1982)
1983 to 1985	Alberta Environment	combined	0.31 in 1984 to 0.44 in 1985	n/a	Gunderson and Rippin (1985), as reported in BP Resources et al. (1985)
1984	Alberta Environment	combined	0.20	n/a	Gunderson (1984), as reported in Canadian Natural (2000)
1984	Alberta Environment	combined	0.44	n/a	Gunderson (1984), as reported in Canadian Natural (2000)
1993	Alberta Environment	combined	0.53	aspen, shrubland and shrubby fen	AENV (1993), as reported Esso (1997)
1995	Solv-Ex	combined	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	white-tailed deer	0.08	most in cleared peatland, riparian shrub and black spruce-tamarack	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, L23 and Steepbank Study Area	white-tailed deer	February: 2 individuals December: 5 individuals	both in deciduous forest 2 in mixedwood and 3 in deciduous forest	Westworth, Brusnyk and Associates (1996c)
1998	Suncor Firebag Project	combined	no observations	n/a	Suncor (2000)
1999	Mobil Lease 36	white-tailed deer mule deer	0.02 in February no observations	one d1 ecosite phase	Golder (1999b)
1999 to 2000	Petro-Canada MacKay River	white-tailed deer	0.15 in December 0.04 in February	most common in d1	AXYS (2000a)
2000	PanCanadian Christina Lake Thermal Project	white-tailed deer	0.02 in late winter	three in c1 ecosite phase	Golder (2000b)
2000	Canadian Natural PAW Project	combined	0.03	observed in b1 and d2 ecosite phase	Canadian Natural (2000)

Table E-5 Deer Aerial Survey Results Within the Region (continued)

Year	Project	Species	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
2000	TrueNorth Fort Hills Oil Sands Project	mule deer	no observations	n/a	Golder (2000a)
2000	TrueNorth Fort Hills Oil Sands Project	white-tailed deer	no observations in January 0.03 km^2 in March	only in b1 ecosite phase in March	Golder (2000a)
2000	OPTI Long Lake Project	combined	0.12 km^2 in January; and not observed in March	observations recorded in the d1, d2 and d3 ecosite phase/wetlands types	OPTI (2000)
2001	Rio Alto Kirby Project	n/a	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	white-tailed deer	0.03	two individuals observed in the d2 ecosite phase/wetlands type	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	combined	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	white-tailed deer mule deer	0.17 0.01	white-tailed deer observed mostly in disturbed habitat, primarily cutblocks, also observed in d3, e1, and SONS mule deer observed in d1 and d2	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Ungulate Aerial Survey	white-tailed deer	0.06 in February	observations occurred within upland areas; majority in d2 and one observation in b3	Golder (2002b)
2003	Petro-Canada Meadow Creek Caribou Aerial Survey	white-tailed deer	0.04 in February	observations occurred within upland areas; d2 and d1 ecosites	Golder (2003a)
2002	Suncor South Tailings Pond Project	combined	no observations	n/a	Golder (2003c)
2002	Devon Jackfish Project	white-tailed deer	0.12	most observations in upland habitats (mixed jack pine- aspen, aspen, mixed aspen- white spruce and jack pine)	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	white-tailed deer	0.17	observations in a1 and g1	Golder (2004a)
2004	MEG Christina Lake Regional Project	combined	no observations	n/a	MEG (2005)

Table E-5 Deer Aerial Survey Results Within the Region (continued)

Year	Project	Species	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
2005 to 2006	Primrose East Expansion	combined	no observations	n/a	Canadian Natural (2006)
2006	Devon – Jackfish 2 Project	white-tailed deer	0.02	observed in upland habitats (aspen and mixed aspen-white spruce)	Devon (2006)
2006 to 2007	Suncor Voyageur South	combined	0.04	observed in d1, d2, FTNN	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	combined	0.11	observed in FTNN	EnCana (2009)
2007	Canadian Natural Kirby	combined	no observations	n/a	Canadian Natural (2007)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	combined	no observations	n/a	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	combined	no observations	n/a	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	combined	not determined	observed in d2 and cutline	MEG (2008)
2008	Total Joslyn Mine Expansion	white-tailed deer	0.06	not determined	Unpublished Data
2008	Enerplus Kirby Project	combined	0.03	n/a	Enerplus (2008)
2008	Cenovus Narrows Lake Project	combined	no observations	n/a	Cenovus (2010)
2008	West Ells SAGD Project	combined	no observations	n/a	Sunshine (2010)
2009	McKay SAGD Pilot Project	combined	no observations	n/a	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	combined	no observations	n/a	Dover OPCO (2010)
2007 and 2011	CPC Surmont Project	combined	0.04 in 2007 and 0.10 in 2011	majority in d1, d2; also detected in BTNN, SONS, burn and disturbed	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	combined	not calculated; only one observation	d2	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	combined	<0.01	STNN	Canadian Natural (2011)

n/a = Not applicable.

Table E-6 Deer Track Count Survey Results Within the Region

Year	Project	Species	Results [Tracks/km-track-day unless otherwise noted]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	combined	no observations	n/a	Penner (1976)
1980	Canstar Project 80	combined	one deer track observed	n/a	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	combined	one individual observed	only in mixedwood forest	Westworth and Brusnyk (1982)
1995	Solv-Ex	combined	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	white-tailed deer	0.26	preferred aspen forest and cleared peatland; avoided jackpine, black spruce/ tamarack, fen wetlands, riparian balsam poplar, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	white-tailed deer	0.09 in February 0.14 in December	preferred closed deciduous forest	Westworth, Brusnyk and Associates (1996a)
1997	Muskeg River Mine	combined	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	combined	no observations	n/a	Golder (1998a,b)
1997	Mobil Kearl Lake	combined	0.04	tracks observed in aspen, aspen-white spruce and jack-pine	URSUS and Komex (1997)
1998	Suncor Firebag Project	combined	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	combined	0.57 in reclaimed 0.0 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	combined	mean: 0.9	most common in d2 and e2	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	white-tailed deer	0.33	most in a1, b1, d2, e1 and e2	Golder (2000a)
2000	Albian Sands Lease 13 West	combined	0.08 in upland 0.02 in riparian	only in aspen dominated only in aspen dominated	Golder (2000c)
2000	Suncor Wildlife Monitoring	combined	0.37 in Lease 86/17 0.57 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	combined	0.75	preferred d2; avoided d1, FTNN	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	combined	3.4	highest track densities in a1 and e2; also found in b1, b2,b3, d1, d2, d3, e1, e3, f1, h1, FONS and FTNN	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	combined	mean densities: 0.08 in January 1999/2000 1.45 in January 2000/2001 0.39 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)

Table E-6 Deer Track Count Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track-day unless otherwise noted]	Habitat	Reference
2001	Rio Alto Kirby Project	combined	0.2	one track observed in SONS	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	combined	1.45	preferred b1 and d2; avoided g1, BTNN and FONS	Petro-Canada (2001)
2001	Canadian Natural Horizon Project	combined	0.07	tracks observed in d1, d2, d3 and BTNN	Canadian Natural (2002)
2001	Jackpine Mine – Phase 1	combined	no observations	n/a	Golder (2002a)
2002	Suncor South Tailings Pond Project	combined	no observations	n/a	Golder (2003c)
2002	Devon – Jackfish Project	combined	0.74	highest track density in f1	Devon (2003)
2003	Cenovus-Christina Lake Thermal Project	combined	4.66	preferred disturbed areas	Golder (2004a)
2004	MEG Christina Lake Regional Project	combined	0.41	no preferences; tracks observed within d1, d2, d3, e2, c1, a1, FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	combined	0.34	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	combined	0.19 0.14	preference for white spruce forests and disturbed areas observed in b3 and BTNN	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	combined	0.83	occurred in a1, b3, BTNN, d1, d2, d3, FTNN, g1, and WONN; preferred WONN, avoided BTNN, c1, and g1	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	combined	1.29	most observed in i1, d3, and d1	Devon (2006)
2005 to 2006	OPTI Long Lake South Project	combined	0.5	most observed in e2	OPTI/Nexen (2006)
2006 to 2007	Suncor Voyageur South	combined	1.35	preference for d2, BTNN	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	combined	1.35	preference for b1, b3 avoidance of b4, BTNN, d2, clearcut, FONS, FTNN, g1, h1, ROW	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	combined	Jackpine - 0.14 Pierre River - 0.31	preference for d2, e3, g1 and cutline FTNN are used significantly less than expected	Shell (2007)

Table E-6 Deer Track Count Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track-day unless otherwise noted]	Habitat	Reference
2007	Kai Kos Dehseh	combined	0.3	most observed in i2	North American (2007)
2008	MEG Christina Lake Regional Project Phase 3	combined	0.41	observed in a1, c1, d1, d2, d3, e2 and FTNN	MEG (2008)
2008	Suncor Mine Dump 9 (MD9)	combined	1.91	preference for d2, e3, g1, h1	Suncor (2008)
2008	Total Joslyn Mine Expansion	combined	0.17	highest densities recorded in b1 and b4	Unpublished Data
2008	Enerplus Kirby Project	combined	0.27	majority observed in b4, FTNN, and STNN	Enerplus (2008)
2009 to 2010	Cenovus Narrows Lake Project	combined	0.49	majority in d1, d2, g1 and FONS, also observed in FTNN and disturbed-linear	Cenovus (2010)
2007 to 2008	MacKay River Commercial Project	combined	<0.01	one deer track found in d1	AOSC (2009)
2008	West Ells SAGD Project	combined	no observations	n/a	Sunshine (2010)
2008 to 2010	Dover Commercial Project	combined	no observations	n/a	Dover OPCO (2010)
2011	CPC Surmont Project	combined	2.01	highest track densitiy observed on linear disturbance and in d2	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	combined	0.57	majority in d1 and d2	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	combined	0.13	highest track densities in h1, b4 and STNN	Present Study

n/a = Not applicable.

Table E-7 White-tailed Deer Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [(a)]	Reference
2005 to 2007	Suncor Voyageur South	Fall	0.33	Suncor (2007)
		Winter	0.40	
		Spring	0.40	
		Summer	0.10	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	0.67	EnCana (2009)
		Winter	no observations	
		Spring	0.58	
		Summer	0.67	
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	0.33	Canadian Natural (2007)
		Winter	no observations	
		Spring	0.16	
		Summer	0.206	
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	0.14	
		Winter	0.03	
		Spring	0.06	
		Summer	0.06	
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.23	MEG (2008)
		Winter	0.09	
		Spring	0.45	
		Summer	0.41	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	0.60	Suncor (2008)
		Winter	no observations	
		Spring	0.20	
		Summer	0.40	

Table E-7 White-tailed Deer Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.25	Unpublished Data
		Winter	no observations	
		Spring		
		Summer	0.08	
2008	Enerplus Kirby Project	Fall	0.67	Enerplus (2008)
		Winter	no observations	
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	0.47	Cenovus (2010)
		Winter	no observations	
		Spring	0.33	
		Summer	0.60	
2008 to 2010	Dover Commercial Project	Fall	no observations	Dover OPCO (2010)
		Winter		
		Spring		
		Summer		
2005	CPC Surmont Project	Fall	0.67	Unpublished Data
		Winter	0.21	
		Spring	0.08	
		Summer	0.46	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.07	Cenovus (2011)
		Winter	0.03	
		Spring	0.07	
		Summer	0.17	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.22	Canadian Natural (2011)
		Winter	no observations	
		Spring	0.13	
		Summer	0.43	

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-8 Caribou Aerial Survey Results Within the Region

Year	Project	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	no observations	n/a	Penner (1976)
1976 to 1978	AOSERP[(a)]	4.17/100 km^2 in winter	black spruce occupied most heavily year round, while aspen or aspen conifer mixes were used very little	Fuller and Keith (1981)
1980	Canstar Project 80	no observations	n/a	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	no observations	n/a	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Study Area	no observations	n/a	Westworth, Brusnyk and Associates (1996c)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1999	Mobil Lease 36	no observations	n/a	Golder (1999b)
2000	PanCanadian Christina Lake Thermal Project	no observations	n/a	Golder (2000b)
2000	True North Fort Hills Oil Sands Project	no observations	n/a	Golder (2000a)
2000	Canadian Natural PAW Project	6 observations	observed in c1/g1	Canadian Natural (2000)
2000	Canadian Natural PAW Project	telemetry survey data	primarily observed in FTNN or FTNR, BTNN, BTNI, BTNR, BTXC, c1 or g1, and a1	Canadian Natural (2000)
2000	OPTI Long Lake Project	0.00/km^2 in January; 0.01/km^2 in March; and 11 incidental observations of caribou sign	deciduous, fen and pond	OPTI (2000)
2001	Petro-Canada Meadow Creek Project	0.35 in February	wooded fen	Petro-Canada (2001)
2001	Rio Alto Kirby Project	no observations aerially; 26 incidental observations	c1 and g1, e1, BTNN, FONS, FTNN, SONS, and WONN	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Devon Jackfish Project	no direct observations	forage sight and tracks observed in treed fen and shrubby bog	Devon (2003)
2002	Petro-Canada Meadow Creek Project	0.03 in February	treed bog	Golder (2002b)

Table E-8 Caribou Aerial Survey Results Within the Region (continued)

Year	Project	Results [Individuals/km^2 unless otherwise noted]	Habitat	Reference
2003	Petro-Canada Meadow Creek Project	0.15 in February	BTNN, FONG, c1, FTNN, MONG, SONS and disturbance (well pads, cutlines)	Golder (2003a)
2003	Cenovus Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	no observations	n/a	MEG (2005)
2004 to 2005	Primrose East Expansion	0.04	FTNN	Canadian Natural (2006)
2006	Devon – Jackfish 2 Project	0.05	shrubby/treed bog and treed fen	Devon (2006)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	no observations	n/a	EnCana (2009)
2007	Canadian Natural Kirby	no observations	n/a	Canadian Natural (2007)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	no observations	n/a	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	0.04	BTNN	MEG (2008)
2008	Total Joslyn Mine Expansion	no observations	n/a	Unpublished Data
2008	Enerplus Kirby Project	no observations	n/a	Enerplus (2008)
2008	Cenovus Narrows Lake Project	no observations	n/a	Cenovus (2010)
2008	West Ells SAGD Project	no observations	n/a	Sunshine (2010)
2009	McKay SAGD Pilot Project	no observations	n/a	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	0.023	BTNN and FTNN	Dover OPCO (2010)
2011	CPC Surmont Project	no observations	n/a	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.02 in February	FTNN and BTNN	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	0.02	a1, c1	Canadian Natural (2011)

(a) AOSERP = Alberta Oil Sands Environmental Research Program.

n/a = Not applicable.

Table E-9 Caribou Track Count Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	no observations	n/a	Penner (1976)
1981	Canstar Project 80	no observations	n/a	Skinner and Westworth (1981)
1982	Canstar Lease	0.01	only in mature mixedwood forest	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, L23 and Steepbank Study Area	no observations	n/a	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Wildlife Monitoring	no observations	n/a	Golder (1998b)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999a)
2000	True North Fort Hills Oil Sands Project	no observations	n/a	Golder (2000a)
2000	Albian Sands Lease 13 West	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	no observations	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	11 incidental observations of caribou sign	deciduous, fen and pond	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	incidental observations in g1, c1, BTNN and FONS	n/a	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	2.1	tracks observed in d1, BTNN, FONS; a preference was observed for the d1 and avoidance of d2 and BTNN	Petro-Canada (2001)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Devon Jackfish Project	no observations	n/a	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.51 (35 individual tracks)	preference for FTNN, avoidance of BTNN, also occurred within a1, c1, cutline, FONS, g1	MEG (2005)
2004 to 2005	Primrose East Expansion	0.27	tracks observed in disturbed-cutline, c1, FONS, FTNN, and WONN; preferred FTNN, avoided d1, d2, g1, and BTNN	Canadian Natural (2006)

Table E-9 Caribou Track Count Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2005	Devon Jackfish 2 Project	no observations	n/a	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.1	most observed in j2 and k1	OPTI/Nexen (2006)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	no observations	n/a	EnCana (2009)
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	no observations	n/a	Canadian Natural (2007)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - one track observed Pierre River - no observations	FONG n/a	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	0.09	most observed in j1, j2	North American (2007)
2008	MEG Christina Lake Regional Project Phase 3	0.04	preferred FTNN and avoided BTNN	MEG (2008)
2008	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2008	Total Joslyn Mine Expansion	no observations	n/a	Unpublished Data
2008	Enerplus Kirby Project	0.05	shrub	Enerplus (2008)
2008	West Ells SAGD Project	no observations	n/a	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	no observations	n/a	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	0.50	preference for FONS (63 tracks) also observed in d2 (15 tracks) and FTNN (13 tracks)	Cenovus (2010)
2008 to 2010	Dover Commercial Project	0.03	BTNN and FTNN	Dover OPCO (2010)
2011	CPC Surmont Project	0.09	highest track density observed in FTNN; also observed in d2 and d1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.07	all tracks but one in BTNN	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.06	primarily in BTNN and FONS; also observed in FTNN, g1 and linear disturbances	Present Study

n/a = Not applicable.

Table E-10 Caribou Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [(a)]	Reference
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter		
		Spring		
		Summer	0.17	
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter		
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	no observations	
		Winter		
		Spring		
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.14	MEG (2008)
		Winter	no observations	
		Spring	0.05	
		Summer	0.18	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		
2007 to 2008	Total Joslyn Mine Expansion	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		

Table E-10 Caribou Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [(a)]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter		
		Spring		
		Summer	0.13	
2008 to 2010	Dover Commercial Project	Fall	0.10	Dover OPCO (2010)
		Winter	no observations	
		Spring	0.05	
		Summer	no observations	
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.07	Cenovus (2011)
		Winter	0.07	
		Spring	0.03	
		Summer	0.10	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter		
		Spring	0.04	
		Summer	0.04	

[(a)] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-11 Wolf Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	0.14 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.07	no preference	Penner (1976)
1975 to 1978	AOSERP	winter densities 1/92 km^2 to 1/198 km^2	n/a	Fuller and Keith (1980b)
1980	Canstar Project 80	0.01	only in jack pine and black spruce-muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.04	preferred willow wetlands and riparian aspen; avoided balsam poplar, jack pine, white spruce and riparian white spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.05	preferred black spruce/tamarack; avoided aspen forest and mixedwood forest	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.14 in December 0.09 in February	avoided closed mixedwood	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.31 in January 0.0 in February 0.0 in March	January: preferred upland, avoided escarpment	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.38	most in lake shore emergent habitat and along main roads	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.09 in reclaimed 0.08 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 0.5	most common in FONG, h1 and d1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000a)
2000	Albian Sands Lease 13 West	0.01 in upland 0.04 in riparian	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.11 in Lease 25/97	only riparian corridors sampled	Golder (2000d)

Table E-11 Wolf Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2000	OPTI Long Lake Project	0.01	tracks observed in the d2 and h1 ecosite phase/wetlands types	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	0.1	observed at low densities in d1, e1, e2, f1, FONS, FTNN and FONG	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.03 in January 1999/2000 0.04 in January 2000/2001 0 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.13	tracks observed in b2, d2 and FONS ecosite / wetlands types	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.07	two sets of tracks observed in d2	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.03	three sets of tracks in d2	Golder (2002a)
2001	Canadian Natural Horizon Project	0.08	tracks observed in b1, d1, d2, d3, FONS and cutblock	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.03	tracks observed in e2 ecosite phase; no habitat preferences determined	Golder (2003c)
2002	Devon Jackfish Project	0.03	tracks observed in a1, d1, i2 and k2	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.03	tracks observed in c1, g1	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.15	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	0.25 0.01	preference for mixedwood forests tracks observed in disturbed-cutline	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	0.32	n/a	Devon (2006)

Table E-11 Wolf Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2005 to 2006	OPTI/Nexen Long Lake South Project	0.1	most observed in b1	OPTI/Nexen (2006)
2005-2007	Suncor Voyageur South	0.17	preference for d1, d2	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.10	avoidance of FTNN	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 0.07 Pierre River - 0.21	preference for d1, d2 b3, BFNN, FTNN and g1 were used significantly less than expected	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	0.09	most observed in b1, d1	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	0.23	observed in b3, b4, c1, d1, d2, e1, g1, FTNN, and disturbed cutlines	MEG (2008)
2007to 2008	Suncor Mine Dump 9 (MD9)	0.11	preference for d1, d2	Suncor (2008)
2007to 2008	Total Joslyn Mine Expansion	0.06	highest track densities recorded in b2 and k2	Unpublished Data
2008	Enerplus Kirby Project	0.10	observed predominantly on a disturbed-cutlines, FTNN, and STNN	Enerplus (2008)
2008	West Ells SAGD Project	0.00	n/a	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0.97 in d1/b2 0.44 in d3 0.12 in j1 0.00 in all other habitats	tracks observed most frequently in d1/b2	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	<0.01	FTNN	Cenovus (2010)
2008 to 2010	Dover Commercial Project	0.03	b1, b3, b4, c1, BONS, BTNN	Dover OPCO (2010)

Table E-11 Wolf Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2011	CPC Surmont Project	0.04	highest track density observed in linear disturbance; also observed in c1, d1, d2, FONS, FTNN and MONG	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.04	d1, d2 and cutblocks	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.09	highest track densities recorded in b2 and linear disturbances. Also observed in d2, FONS, FTNN, g1, STNN and shrubland.	Present Study

n/a = Not applicable.

Table E-12 Wolf Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	0.11	Suncor (2007)
		Winter	no observations	
		Spring		
		Summer		
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	0.08	EnCana (2009)
		Winter	no observations	
		Spring		
		Summer		
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter		
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	0.14	
		Winter	0.03	
		Spring	no observations	
		Summer	0.06	
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.05	MEG (2008)
		Winter	no observations	
		Spring	0.05	
		Summer	0.09	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.17	Unpublished Data
		Winter	no observations	
		Spring		
		Summer		

Table E-12 Wolf Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [(a)]	Reference
2008	Enerplus Kirby Project	Fall	0.17	Enerplus (2008)
		Winter	no observations	
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	0.17	Cenovus (2010)
		Winter	no observations	
		Spring		
		Summer		
2008 to 2010	Dover Commercial Project	Fall	0.05	Dover OPCO (2010)
		Winter	no observations	
		Spring	0.25	
		Summer	0.25	
2005	CPC Surmont Project Area	Fall	no observations	Unpublished Data
		Winter	0.04	
		Spring	0.17	
		Summer	0.13	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.10	Cenovus (2011)
		Winter	0.07	
		Spring	0.10	
		Summer	0.03	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.13	Canadian Natural (2011)
		Winter	no observations	
		Spring	0.13	
		Summer	0.22	

[(a)] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-13 Coyote Survey Results Within the Region

Year	Project	Results [Tracks/km–track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	0.44 animals/100 km^2	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.29	preferred disturbed habitat; avoided aspen, aspen-willow/alder and black spruce-willow	Penner (1976)
1978	Syncrude Alsands	0.29	n/a	Alsands (1978)
1979	Esso Cold Lake Production Project	0.35 individuals/km^2	n/a	Esso (1979)
1980	Canstar Project 80	0.10	preferred black spruce-muskeg; avoided aspen, open muskeg and riparian shrub	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.13	preferred balsam poplar and jack pine; avoided aspen, white spruce willow and fen	Westworth and Brusnyk (1982)
1995	Solv-Ex	0.72	most tracks in jack pine and black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.09	avoided cleared aspen and willow wetlands	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.45 in December 0.13 in February	preferred closed deciduous; avoided closed jack pine/white spruce, open black spruce and shoreline	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	0.10	most found in closed balsam poplar, closed mixedwood-white spruce dominant and closed white spruce	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.24 in January 0.0 in February 0.0 in March	January: preferred upland	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.06 in January 0.03 in February	January: no preference February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	0.06	no preference	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.03	no preference	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	2.23 in reclaimed 1.75 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 0.6	most common in d3	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.02	only in d2, e1, e2 and shrub	Golder (2000a)
2000	Albian Sands Lease 13 West	0.03 in upland 0.11 in riparian	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.68 in Lease 86/17 0.89 in Lease 25/97	only riparian corridors sampled	Golder (2000d)

Table E-13 Coyote Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km–track day unless otherwise noted]	Habitat	Reference
2000	OPTI Long Lake Project	0.26	no preference; however most tracks were recorded in the FTNN, SONS, d2, d1 and STNN ecosite phase/wetlands types	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	0.5	found in most ecosite phase/wetlands types (b1,b2, b3, c1, d1, d2, d3, e2, e3, f1, f2, h1, BTNN, FTNN, FONS and FONG)	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.08 in January 1999/2000 0.74 in January 2000/2001 0.17 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.13	no preferences; however, most tracks observed in the d2 and g1 ecosite/wetlands types	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.57	almost all tracks observed in d2 ecosite phase/wetlands type, but three sets observed in BTNN; preferred d2, avoided BTNN and FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.01	one set of tracks in FTNN	Golder (2002a)
2001	Canadian Natural Horizon Project	0.20	tracks observed in b1, d2, d3, e3, g1, h1, FTNN, FONS and BTNN; preference for d2, avoidance of d1 (no observations)	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.60	tracks observed in d2 and FTNN ecosite/ wetlands types; no habitat preferences determined	Golder (2003c)
2002	Devon Jackfish Project	1.29	highest densities in k3 and reclaimed industrial sites	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	0.50	most tracks observed along rights-of-way and in BTNN	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.45	highest density in e2, also occurred in a1, b4, c1, d2, d3, e2, FTNN, g1	MEG (2005)
2004	Suncor Monitoring Five Year Report	1.62	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	1.04 0.49	preference for disturbed areas observed in a1, b1, b3, b4, d2, d3, g1, BTNN, disturbed-cutline	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	0.12	observed in FONS, WONN, and SONS	Canadian Natural (2006)

Table E-13 Coyote Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km–track day unless otherwise noted]	Habitat	Reference
2005	Devon Jackfish 2 Project	0.61	most observed in i1 and h1	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.2	most observed in f1	OPTI/Nexen (2006)
2005 to 2007	Suncor Voyageur South	0.17	preference for e1, ROW	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.43	preference of BTNN avoidance of FTNN	EnCana (2009)
2005 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 0.21 Pierre River - 0.09	preference for d1 FTNN and h1 were used significantly less than expected	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	0.20	most observed in e1	North American (2007)
2007to 2008	MEG Christina Lake Regional Project Phase 3	0.31	most occurred on cutlines	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	0.20	preference for e1, ROW	Suncor (2008)
2007to 2008	Total Joslyn Mine Expansion	0.17	highest track density recorded in k2	Unpublished Data
2008	Enerplus Kirby Project	0.07	observed predominantly within shrub and on a disturbed road	Enerplus (2008)
2008	West Ells SAGD Project	0.04	deciduous	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0.30 in j1 0.00 in all other habitats	j1	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	0.09	highest track densities in b3 and disturbed-linear, also observed in b1, c1, g1 and FONS	Cenovus (2010)
2008 to 2010	Dover Commercial Project	no observations	n/a	Dover OPCO (2010)
2011	CPC Surmont Project	0.28	highest track density observed in f2 and linear disturbance; also observed in BTNN, FONS and SONS	Unpublished Data

Table E-13 Coyote Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km–track day unless otherwise noted]	Habitat	Reference
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.12	primarily in cutlblocks and BTNN, also observed in c1, FONS, FTNN, STNN and WONN	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.27	Highest track densities recorded in b2, d3 and linear disturbances	Present Study

n/a = Not applicable.

Table E-14 Coyote Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [(a)]	Reference
2005 to 2007	Suncor Voyageur South	Fall	no observations	Suncor (2007)
		Winter		
		Spring	0.20	
		Summer	0.10	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter	0.17	
		Spring	0.17	
		Summer	0.17	
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter		
		Spring		
		Summer	0.20	
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	no observations	
		Winter		
		Spring		
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.23	MEG (2008)
		Winter	no observations	
		Spring	0.09	
		Summer	0.23	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.08	Unpublished Data
		Winter	no observations	
		Spring		
		Summer		

Table E-14 Coyote Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [(a)]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring	0.33	
		Summer	0.17	
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter	0.07	
		Spring	0.13	
		Summer	0.13	
2008 to 2010	Dover Commercial Project	Fall	0.05	Dover OPCO (2010)
		Winter	0.05	
		Spring	no observations	
		Summer		
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring	0.13	
		Summer	0.25	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.17	Cenovus (2011)
		Winter	0.13	
		Spring	0.07	
		Summer	no observations	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.09	Canadian Natural (2011)
		Winter	no observations	
		Spring	0.13	
		Summer	0.09	

[(a)] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-15 Red Fox Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	0.59 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.02	most found in disturbed habitat and forested black spruce	Penner (1976)
1980	Canstar Project 80	0.08	avoided aspen and open muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.02	avoided aspen, white spruce, fen and willow wetlands	Westworth and Brusnyk (1982)
1995	Solv-Ex	0.95	most tracks in aspen and aspen-white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.01	found in mixedwood forest, fen wetlands, cleared peatland, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.02	only in closed deciduous, disturbed and mixed coniferous	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.05 in January 0.02 in February 0.0 in March	January: no preference February: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	tracks recorded in closed black spruce and dwarf birch-willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.01	only in c1, FONS and FTNN/FFNN	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.03 in reclaimed 0.23 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 0.1	observed in e2 and d1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.03	found in d2, d3 and shrub	Golder (2000a)
2000	Albian Sands Lease 13 West	0.31 in upland 0.10 in riparian	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.39 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.19	most tracks observed in the h1 and d2 ecosite phase	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	0.1	one observation in b2 ecosite phase	Gulf (2001)

Table E-15 Red Fox Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.15 in January 1999/2000 0 in January 2000/2001 0.01 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.36	observed in b1, b3, c1, d2, e2 and BTNN	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.03	observed in BTNN	Golder (2002a)
2001	Canadian Natural Horizon Project	one set of tracks observed	tracks observed in SONS	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003c)
2002	Devon Jackfish Project	0.10	not able to determine preference	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	only 1 incidental observation	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.01	unable to determine preference, observed in FTNN	MEG (2005)
2004	Suncor Voyageur	0.02 no observations	preference for open habitats with brushy shelter n/a	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.02	most observed in b4 and d1	OPTI/Nexen (2006)
2005 to 2007	Suncor Voyageur South	0.03	observed in d1, d2, ROW, no demonstrated preference	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.08	observed in b3, BTNN, e3, FTNN, g1	EnCana (2009)
2005 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	0.02	observed in BTNN, clearcut, cutline, d1,d2, d3	Shell (2007)

Table E-15 Red Fox Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2007	Kai Kos Dehseh	0.02	most observed in d1	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	0.03	observed only on cutlines and roads	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	0.04	observed in g1	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	0.01	observed in d1	Unpublished Data
2008	Enerplus Kirby Project	no observations	n/a	Enerplus (2008)
2008	West Ells SAGD Project	0.00	n/a	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0.00	n/a	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	no observations	n/a	Cenovus (2010)
2008 to 2010	Dover Commercial Project	no observations	n/a	Dover OPCO (2010)
2011	CPC Surmont Project	0.11	highest track density observed in h1 and linear disturbance	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.13	primarily in BTNN and cutblocks, also detected in b1, g1, FONS and FTNN	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.01	only observed in e3 and on linear disturbances	Present Study

n/a = Not applicable.

Table E-16 Red Fox Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	no observations	Suncor (2007)
		Winter		
		Spring		
		Summer		
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter		
		Spring		
		Summer		
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural 2007
		Winter		
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	no observations	
		Winter		
		Spring		
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.05	MEG (2008)
		Winter	no observations	
		Spring		
		Summer		
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		

Table E-16 Red Fox Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [(a)]	Reference
2007 to 2008	Total Joslyn Mine Expansion	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	0.07	Cenovus (2010)
		Winter	no observations	
		Spring		
		Summer		
2008 to 2010	Dover Commercial Project	Fall	no observations	Dover OPCO (2010)
		Winter		
		Spring		
		Summer		
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.10	Cenovus (2011)
		Winter	0.07	
		Spring	no observations	
		Summer	no observations	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter		
		Spring		
		Summer		
		Summer		

[(a)] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-17 Canada Lynx Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	3.37 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.002	only in black spruce	Penner (1976)
1980	Canstar Project 80	0.06	preferred black spruce-muskeg; avoided aspen, mixedwood, open muskeg, riparian shrub and riparian white spruce	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.13	preferred aspen and riparian aspen; avoided jack pine, white spruce, black spruce, fen and willow wetlands	Westworth and Brusnyk (1982)
1985	BP Resources (Wolf Lake)	0.1 individuals/km^2	n/a	BP Resources et al. (1985)
1995	Solv-Ex	0.24	only in black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	no observations in December 0.01 in February	only in closed deciduous, mixed coniferous, black spruce-tamarack and disturbed	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.0 in January 0.02 in February 0.05 in March	February: no preference March: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	no observations	n/a	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999a)
1999	AEC Foster Creek SAGD Project	no overall tracks/km-track day provided	tracks found in coniferous forest (jack pine/black spruce, treed bogs and shrubby fens	AXYS (1999)
2000	ATCO Pipeline	mean: 3.2	most common in FONG, and FONS	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.01	found in d2 and e2	Golder (2000a)
2000	Albian Sands Lease 13 West	0.13 in upland 0.14 in riparian	n/a	Golder (2000c)

Table E-17 Canada Lynx Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.04 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.50	most tracks were recorded in the d2, d1, FTNN and h1 ecosite phase/wetlands types	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	0.9	found in most ecosite phase/wetlands types (a1, b1, b2, b3, c1, d1, d2, d3, e2, e3, g1, h1, BTNN, FTNN, FONS and FONG)	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.14 in January 1999/2000 0.21 in January 2000/2001 0.28 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.25	no preference observed, tracks found in b3, g1, FONS, FTNN, STNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.34	found most commonly in the BTNN and g1, but also observed in BFNN, c1, STNN	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.54	preferred d2; avoided FONS	Golder (2002a)
2001	Canadian Natural Horizon Project	0.84	tracks observed in b3, d1, d2, d3, e3, g1, BTNN, FTNN, FONS, STNN, SONS and WONN; preference for d1, avoidance of d2, FONG, SONS and burn	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.41	tracks observed in d2 ecosite phase; with habitat preference for d2 and avoidance of FONS determined	Golder (2003c)
2002	Devon Jackfish Project	0.56	highest track densities in k1 and j1	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	not observed	n/a	Golder (2004a)
2004	Suncor Monitoring Five Year Report	0.08	surveys conducted in natural sites	Golder (2004b)
2004	MEG Christina Lake Regional Project	0.13	no preferences, highest densities in disturbed-cutline, BTNN	MEG (2005)

Table E-17 Canada Lynx Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2004	Suncor Voyageur	0.06 0.04	no preference determined observed in SONS, FTNN and disturbed - road	Golder (2005)
2004 to 2005	Primrose East Expansion	0.04	observed in FTNN and g1	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	0.05	observed in a1, b1, c1, and g1	Devon (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in f2 and f3	OPTI/Nexen (2006)
2005 to 2006	Suncor Voyageur South	0.02	observed in b1, b3, b4, BTNN, FONS, FTNN, g1, road habitats, no preference demonstrated	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.09	avoidance of FTNN	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 0.11 Pierre River - 0.07	observed in b1, b3, BTNN, d2, d3, FONS, FTNN, g1 and roads	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	0.04	most observed in h1, c1, g1	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	0.06	tracks occurred in b4, d2, f3, and h1	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	0.16	highest track density recorded in g1	Unpublished Data
2008	Enerplus Kirby Project	0.07	observed predominantly within shrub habitat and additionally in BTNN and disturbed road	Enerplus (2008)
2008	West Ells SAGD Project	0.1	lowland shrub, mixed coniferous, and deciduous dominated mixed-wood	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0.46 in c1 0.67 in g1 1.01 in d1/b2 0.15 in i1 0.33 in j2 0.13 in k1 2.00 in l1 0.00 in all other habitats	tracks observed predominantly in l1 and d1/b2	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	0.10	tracks occurred in d2 and FTNN	Cenovus (2010)

Table E-17 Canada Lynx Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2008 to 2010	Dover Commercial Project	0.23	most tracks observed in BONS and BTNN; highest density in linear disturbed; preference for BONS	Dover OPCO (2010)
2011	CPC Surmont Project	0.54	highest track density observed in f2 and linear disturbance	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.19	primarily FTNN and STNN, also detected in b1, c1, d2, g1, BTNN, FONS, SONS and cutblock	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.38	highest track densities recorded in linear disturbances followed by h1 and BTNN	Present Study

n/a = Not applicable.

Table E-18 Canada Lynx Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	0.11	Suncor (2007)
		Winter	0.10	
		Spring	0.10	
		Summer	no observations	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	0.08	EnCana (2009)
		Winter	no observations	
		Spring	0.08	
		Summer	no observations	
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	0.16	Canadian Natural (2007)
		Winter	no observations	
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	0.14	
		Winter	no observations	
		Spring		
		Summer		
		Pierre River Mine		
		Fall	no observation	
		Winter	0.03	
		Spring	no observations	
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.05	MEG (2008)
		Winter	0.09	
		Spring	0.09	
		Summer	no observations	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		
2007 to 2008	Total Joslyn Mine Expansion	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		

Table E-18 Canada Lynx Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter	0.17	
		Spring	no observations	
		Summer	0.17	
2009 to 2010	Cenovus Narrows Lake Project	Fall	0.07	Cenovus (2010)
		Winter	0.07	
		Spring	0.07	
		Summer	no observations	
2008 to 2010	Dover Commercial Project	Fall	0.35	Dover OPCO (2010)
		Winter	0.25	
		Spring	0.40	
		Summer	0.45	
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring	0.04	
		Summer	0.08	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.17	Cenovus (2011)
		Winter	0.13	
		Spring	0.20	
		Summer	0.10	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.04	Canadian Natural (2011)
		Winter	0.08	
		Spring	0.13	
		Summer	0.13	

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-19 Black Bear Survey Results Within the Region

Year	Project	Results	Reference
1976	Alberta Environment	0.38 bears/km^2	Ruff et al. (1976)
1977	AOSERP[(a)]	1 bear/2 to 4 km^2	Fuller and Keith (1977)
1978	AOSERP[(a)]	1bear/4 to 5.6 km^2	Young (1978)
1980	AOSERP[(a)]	25 to 50/100 km^2 (telemetry)	Fuller and Keith (1980a)
1981 to 1982	Canstar Lease	highest use in balsam poplar, mixedwood and white spruce; jack pine and black spruce habitats were low, while fen and willow wetlands were avoided	Westworth and Brusnyk (1982)
1982	Cold Lake	18 to 25/100 km^2 (telemetry)	Young and Ruff (1982)
1998	Suncor Firebag Project	12 incidental observations of individuals or sign	Suncor (2000)
2000	Canadian Natural PAW Project	incidental observations in black spruce/jack pine, jack pine/aspen, treed fen, shrubby fen, aspen/white spruce, poor fen/bog, shrubby swamp, jack pine and cutblocks	Canadian Natural (2000)
2000	OPTI Long Lake Project	7 incidental observations of individuals or sign	OPTI (2000)
1998 and 2000	Gulf Surmont In-situ Oil Sands Project	12 incidental observations of individuals or sign in b2, d1, d2, e2, f1, d1 and FONS	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	9 incidental observations of individuals or sign in b1, d1, d3, e1	Petro-Canada (2001)
2001	Rio Alto Kirby Project	8 incidental observations in b3, e2, and BTNN	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	5 incidental observations in SONS, d2 and d3	Golder (2002a)
2001	Canadian Natural Horizon Project	14 incidental observations in b1, d1, d2	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	7 incidental observations in d2 ecosite phase and cutblocks	Golder (2003c)
2002	Devon Jackfish Project	no observations	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	4 observations of bear or evidence of bear	Golder (2004a)
2004	MEG Christina Lake Regional Project	8 incidental observations or evidence of bear within d2 and along cutlines	MEG (2005)
2004	Suncor Voyageur	3 incidental sightings in d2 1 incidental sighting in FTNN	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	36 observations of sign in SONS, g1, c1, d2i incidental observations of individuals in d2, h1, and STNN	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	no observations of sign	Devon (2006)
2005 to 2007	Suncor Voyageur South	no incidental sightings	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	2 incidental sightings in c1, g1	EnCana (2009)
2006 to 2007	Canadian Natural Kirby	1 incidental observation	Canadian Natural (2007)

Table E-19 Black Bear Survey Results Within the Region (continued)

Year	Project	Results	Reference
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	26 incidental observations	Shell (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	8 incidental observations	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	4 incidental observations	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	7 incidental sightings in d1, d2, d3, FONS, and g1	Unpublished Data
2008	Enerplus Kirby Project	7 incidental observations	Enerplus (2008)
2007 to 2010	Cenovus Narrows Lake Project	3 incidental observations	Cenovus (2010)
2008 to 2009	MacKay River Commercial Project	3 black bears detected incidentally—no targeted surveys	AOSC (2009)
2008	West Ells SAGD Project	none observed	Sunshine (2010)
2009	McKay SAGD Pilot Project	none observed	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	17 incidental observations 1 bear trapped	Dover OPCO (2010)
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	8 incidental observations	Cenovus (2011)
2001, 2008, 2009 and 2011	Canadian Natural Kirby Expansion	14 incidental observations	Canadian Natural (2011)

(a) AOSERP = Alberta Oil Sands Environmental Research Program.

Table E-20 Black Bear Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [(a)]	Reference
2005 to 2007	Suncor Voyageur South	Fall	no observations	Suncor (2007)
		Winter	n/a	
		Spring	0.20	
		Summer	0.50	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter	n/a	
		Spring	0.25	
		Summer	0.33	
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter	n/a	
		Spring	0.83	
		Summer	0.08	
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter	n/a	
		Spring	no observations	
		Summer		
		Pierre River Mine		
		Fall	no observations	
		Winter	n/a	
		Spring	0.69	
		Summer	0.75	
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	0.27	MEG (2008)
		Winter	n/a	
		Spring	0.41	
		Summer	0.36	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	0.20	Suncor (2008)
		Winter	n/a	
		Spring	0.20	
		Summer	0.40	
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.17	Unpublished Data
		Winter	n/a	
		Spring	0.08	
		Summer	0.58	

Table E-20 Black Bear Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter	n/a	
		Spring	0.67	
		Summer	0.50	
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter	n/a	
		Spring	0.27	
		Summer	0.33	
2008 to 2010	Dover Commercial Project	Fall	0.70	Dover OPCO (2010)
		Winter	n/a	
		Spring	0.55	
		Summer	0.75	
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring	0.54	
		Summer	0.46	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	no observation	Cenovus (2011)
		Winter	n/a	
		Spring	0.27	
		Summer	0.57	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.17	Canadian Natural (2011)
		Winter	n/a	
		Spring	0.65	
		Summer	0.26	

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

n/a = not applicable.

Table E-21 Wolverine Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	0.01 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.01	only in aspen and mixedwood	Penner (1976)
1979	Syncrude Lease 17	estimated 0.08 individuals/100 km^2	n/a	Westworth (1979)
1980	Canstar Project 80	0.005	only in black spruce-muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	no observations	n/a	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	no observations	n/a	Westworth, Brusnyk and Associates (1996c)
1997	Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	in a black spruce burn and along seismic line through white spruce-aspen mixedwood	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999a)
2000	ATCO Pipeline	no observations	n/a	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000a)
2000	Albian Sands Lease 13 West	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	no observations	n/a	Golder (2000d)
2000	OPTI Long Lake Project	no observations	n/a	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	no observations	n/a	Golder (2001a)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	no observations	n/a	Petro-Canada (2001)
2001	Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003c)

Table E-21 Wolverine Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2002	Devon – Jackfish Project	no observations	n/a	Devon (2003)
2003	Cenovus – Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	no observations	n/a	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.004	surveys conducted in natural sites	Golder (2004b)
2004	La Loche Road Link Project	1 track	Christina River	Golder (2004c)
2004	Suncor Voyageur	1 set of tracks no observations	observed in e3 n/a	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Canadian Natural Devon Jackfish 2 Project	no observations	n/a	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	no observations	n/a	OPTI/Nexen (2006)
2005 to 2007	Suncor Voyageur South	0.02	observed in BTNN, 1 individual	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	no observations	n/a	EnCana (2009)
2005 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	0.01	observed in a1, b1, b3, b4, c1, d2, d3, e2, e3, FTNN, FONG, riparian, cutline	Shell (2007)
2007	Kai Kos Dehseh	no observations	n/a	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	0.03	c1	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	no observations	n/a	Unpublished Data
2008	Enerplus Kirby Project	no observations	n/a	Enerplus (2008)
2007 to 2008	MacKay River Commercial Project	no observations	n/a	AOSC (2009)
2008	West Ells SAGD Project	no observations	n/a	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	no observations	n/a	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	no observations	n/a	Cenovus (2010)
2008 to 2010	Dover Commercial Project	no observations	n/a	Dover OPCO (2010)

Table E-21 Wolverine Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2011	CPC Surmont Project	0.01; also a visual incidental in 2007	tracks observed in linear disturbance and d2; incidental observation in c1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	no observations	n/a	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	no observations	n/a	Present Study

n/a = Not applicable.

Table E-22 Wolverine Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	no observations	Suncor (2007)
		Winter		
		Spring		
		Summer		
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter		
		Spring		
		Summer		
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter		
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	0.04	
		Winter	0.03	
		Spring	no observations	
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	no observations	MEG (2008)
		Winter		
		Spring		
		Summer		
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		

Table E-22 Wolverine Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [(a)]	Reference
2007 to 2008	Total Joslyn Mine Expansion	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter		
		Spring		
		Summer		
2008 to 2010	Dover Commercial Project	Fall	0.05	Dover OPCO (2010)
		Winter	no observations	
		Spring	0.05	
		Summer	no observations	
2005	CPC Surmont Project	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	no observations	Cenovus (2011)
		Winter		
		Spring		
		Summer		
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter		
		Spring		
		Summer		

[(a)] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-23 Fisher and Marten Survey Results Within the Region

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	fisher	0.43 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	fisher	0.06	no preference	Penner (1976)
1986	OSLO[(a)]	fisher	no overall track count/km-track day provided	tracks were found in bogs, shrublands and fens	Duncan et al. (1986)
1995	Solv-Ex	fisher	1.52	most tracks in jack pine, white spruce and aspen-white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	fisher	0.02 in January	most in riparian balsam poplar	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	fisher	0.21 in December 0.04 in February	preferred black spruce tamarack; avoided upland coniferous/ mixedwood	Westworth, Brusnyk and Associates (1996c)
1997	Suncor Winter Wildlife	fisher	0.0 in January 0.29 in February	February: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	fisher	0.02 in January 0.59 in February 0.15 in March	January: no preference February: prefer upland, avoid riparian and escarpment March: no preference	Golder (1998a,b)
1997	Mobil Lease 36	fisher	0.09	most in treed fens and bogs	URSUS and Komex (1997)
1998	Suncor Firebag Project	fisher	0.61	avoided b1, b2, d2 and d3	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	fisher	0.03 in reclaimed 1.64 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	fisher	mean: 0.6	most common in b1, also common in FTNN and FONS	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	fisher	0.14	found in b1, d1, d2, BTNN and FTNN	Golder (2000a)
2000	Albian Sands Lease 13 West	fisher	0.81 in upland 1.16 in riparian	no landform preference	Golder (2000c)
2000	Suncor Wildlife Monitoring	fisher	0.0 in Lease 86/17 0.46 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	fisher	0.45	d2, h1	OPTI (2000)

Table E-23 Fisher and Marten Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1999 to 2001	Albian Sands Lease 13 West	fisher	mean densities: 1.02 in January 1999/2000 0.47 in January 2000/2001 0.77 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Petro-Canada Meadow Creek Project	fisher	0.74	most often in d2 and e2 ecosite phase/wetlands types but also found in b1, e1, BTNN, STNN	Petro-Canada (2001)
2000	Gulf Surmont In-situ Oil Sands Project	fisher	0.2	highest densities in a1, also found in b2, c1, d1, d2, d3, e2, e3, g1, h1, FTNN and FONS	Gulf (2001)
2001	Rio Alto Kirby Project	fisher	0.06	no preference but tracks observed in b3, c1, g1	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	fisher	1.00	most often in FTNN, FONS, STNN, BTNN; incidentally observed on four occasions in h1, STNN, FTNN and FONG ecosite phase/wetlands types	Golder (2002a)
2001	Canadian Natural Horizon Project	fisher	0.19	tracks observed most often in d2, also observed in d3, g1 and cutblock	Canadian Natural (2002)
2006	OPTI/Nexen Long Lake South Project	fisher	0.06	most observed in b4	OPTI/Nexen (2006)
1970 to 1975	traplines	marten	animals/100 km^2 trapped	n/a	Boyd (1977)
1995	Solv-Ex	marten	0.08	only in black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	marten	0.15 in January	preferred mixed coniferous and riparian white spruce; avoided black spruce- tamarack, open tamarack- bog birch, fen wetlands, willow wetlands, riparian balsam poplar, riparian shrub and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	marten	0.04 in December 0.10 in February	preferred upland coniferous	Westworth, Brusnyk and Associates (1996a)
1997	Suncor Winter Wildlife	marten	0.38 in January 1.16 in February	January: avoided d1, d2, d3, shrub and WONN February: avoided a1 and d1	Golder (1998a,b)

Table E-23 Fisher and Marten Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1997	Suncor Winter Wildlife	marten	0.36 in January 0.35 in February 0.44 in March	January: avoided upland February: no preference march: preferred escarpment and avoid riparian	Golder (1998a,b)
1997	Mobil Lease 36	marten	1.03	most in riparian willow shrubland, white spruce – aspen mixedwood and white spruce	URSUS and Komex (1997)
1998	Suncor Firebag Project	marten	1.33	preferred FTNN/FFNN and avoided FONS	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	marten	0.03 in reclaimed 1.49 in riparian area beside disturbance	n/a	Golder (1999b)
2000	TrueNorth Fort Hills Oil Sands Project	marten	0.42	preferred b1 and BTNN avoided d1, d3, e1, g1, shrub and sons	Golder (2000a)
2000	Albian Sands Lease 13 West	marten	0.28 in upland 0.50 in riparian	no landform preference	Golder (2000c)
2000	ATCO Pipeline	marten	mean: 1.8	most common in BTNN and shrubby bog, also common in d3 and h1	AXYS (2000b)
2000	Suncor Wildlife Monitoring	marten	0.0 in Lease 86/17 0.54 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	marten	0.02	tracks observed in the d2 and FTNN ecosite phase/wetlands types	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	marten	mean densities: 0.41 in January 1999/2000 0.52 in January 2000/2001 1.02 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2000	Gulf Surmont In-situ Oil Sands Project	marten	0.1	highest densities of tracks found in e2 and g1, also found in b1, d1, d2, e3, f1, h1, BTNN, FONS and FTNN	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	marten	0.57	most often observed in b3 and d2 but also observed in c1, g1, e1 and BTNN	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	marten	0.46	most observed in FTNN, b1, BTNN and FONS	Golder (2002a)

Table E-23 Fisher and Marten Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2001	Canadian Natural Horizon Project	marten	0.42	most observed in d2, also observed in d1, d3, e3, g1, BTNN, FTNN, FONS and STNN	Canadian Natural (2002)
1997	Shell Muskeg River Mine	combined	1.26	preferred closed balsam poplar, closed mixedwood, open and closed aspen	Golder (1997a,b)
2005 to 2006	OPTI/Nexen Long Lake South Project	marten	0.2	most observed in l1	OPTI/Nexen (2006)
1981	Canstar Project 80	combined	0.05	no preference	Skinner and Westworth (1981)
1982	Canstar Lease	combined	0.12	preferred mixedwood; avoided white spruce, black spruce, willow, fen and willow wetlands	Westworth and Brusnyk (1982)
1999	AEC Foster Creek SAGD Project	combined	tracks observed	n/a	AXYS (1999)
2000	OPTI Long Lake Project	combined	0.47	d2, h1	OPTI (2000)
2001	Rio Alto Kirby Project	combined	0.17	tracks observed in b3, c1, d2, g1	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	combined	1.40	most often observed in d2, b3, e2 and BTNN; preferred d2 and avoided FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	combined	1.75	most often observed in FTNN, FONS, BTNN and STNN; preferred FTNN, avoided d2 and h1	Golder (2002a)
2001	Canadian Natural Horizon Project	combined	0.97	most often observed in d2 (high effort), e3 and d1 but no significant preference or avoidance of habitat types	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	combined	0.85	most often observed in FONS wetlands type, also observed in BTNN, d2, and FTNN; preference for FONS and avoidance of d2 determined	Golder (2003c)
2002	Devon Jackfish Project	combined	0.29	highest track densities in g1	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	combined	no observations	n/a	Golder (2004a)

Table E-23 Fisher and Marten Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2004	MEG Christina Lake Regional Project	combined	0.09	No preferences could be determined but recorded within g1, BTNN, FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	combined	1.45	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	combined	1.00 1.37	preference for deciduous and white spruce forests preference for b3	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	combined	0.11	most in g1	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	combined (>90% fisher)	0.08	observed in sc, g1, burn area, and b1	Devon (2006)
2005 to 2007	Suncor Voyageur South	combined	1.34	preference for d1	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	combined	0.26	avoidance of FTNN	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	combined	Jackpine - 1.73 Pierre River - 2.33	preference for d1 FTNN is used significantly less than expected	Shell (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	combined	0.03	BTNN and FTNN	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	combined	4.13	preference for d1	Suncor (2008)
2007 to 2008	Total Joslyn Mine Expansion	combined	0.31 0.64	highest track density recorded in f1 and f2 highest track density recorded in a1and f1	Unpublished Data
2008	Enerplus Kirby Project	combined	0.14	exclusively within shrub habitat, other than one occurrence in a BTNN	Enerplus (2008)
2008	West Ells SAGD Project	marten	2.2	primarily in lowland treed and white spruce habitats	Sunshine (2010)

Table E-23 Fisher and Marten Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2008 to 2009	McKay SAGD Pilot Project	combined	0.19 in c1 1.43 in h1 0.38 in i2 0.74 in j1 0.13 in k1 0.67 in l1 0.00 in all other habitats	primarily in h1 and j1	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	combined	0.13	recorded mostly within d2 and d3, also observed in d1, g1, BTNN, FTNN and disturbed-linear	Cenovus (2010)
2008 to 2010	Dover Commercial Project	combined	0.57 0.05	most tracks observed in BTNN; highest density in e2	Dover OPCO (2010)
2011	CPC Surmont Project	combined	0.60	highest track density observed in e3 and burned upland	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	combined	1.29	primarily in FTNN and BTNN also detected in b1, c1, d1, d2, e2, g1, FONS, STNN and cutblocks	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	Combined	0.14	highest track density in h1	Present Study

[a] OSLO = Other Six Lease Owners.

n/a = Not applicable.

Table E-24 Fisher Photographic Bait Station Results Within the Region

<table>
<tr><th>Year</th><th>Project</th><th>Season</th><th>Occurrence Rate [a]</th><th>Reference</th></tr>
<tr><td rowspan="4">2005 to 2007</td><td rowspan="4">Suncor Voyageur South</td><td>Fall</td><td>no observations</td><td rowspan="4">Suncor (2007)</td></tr>
<tr><td>Winter</td><td>0.10</td></tr>
<tr><td>Spring</td><td>0.20</td></tr>
<tr><td>Summer</td><td>no observations</td></tr>
<tr><td rowspan="4">2006</td><td rowspan="4">Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G</td><td>Fall</td><td rowspan="2">no observations</td><td rowspan="4">EnCana (2009)</td></tr>
<tr><td>Winter</td></tr>
<tr><td>Spring</td><td>0.20</td></tr>
<tr><td>Summer</td><td>0.08</td></tr>
<tr><td rowspan="4">2006 to 2007</td><td rowspan="4">Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project</td><td>Fall</td><td>0.16</td><td rowspan="4">Canadian Natural (2007)</td></tr>
<tr><td>Winter</td><td rowspan="3">no observations</td></tr>
<tr><td>Spring</td></tr>
<tr><td>Summer</td></tr>
<tr><td rowspan="10">2006 to 2007</td><td rowspan="10">Shell Jackpine Mine Expansion and Pierre River Mine Project</td><td colspan="2">Jackpine Mine Expansion</td><td rowspan="10">Shell (2007)</td></tr>
<tr><td>Fall</td><td>0.14</td></tr>
<tr><td>Winter</td><td>0.22</td></tr>
<tr><td>Spring</td><td>no observations</td></tr>
<tr><td>Summer</td><td>0.13</td></tr>
<tr><td colspan="2">Pierre River Mine</td></tr>
<tr><td>Fall</td><td>0.18</td></tr>
<tr><td>Winter</td><td>0.06</td></tr>
<tr><td>Spring</td><td>0.09</td></tr>
<tr><td>Summer</td><td>0.09</td></tr>
<tr><td rowspan="4">2007 to 2008</td><td rowspan="4">MEG Christina Lake Regional Project Phase 3</td><td>Fall</td><td>0.05</td><td rowspan="4">MEG (2008)</td></tr>
<tr><td>Winter</td><td>0.14</td></tr>
<tr><td>Spring</td><td>0.05</td></tr>
<tr><td>Summer</td><td>0.09</td></tr>
<tr><td rowspan="4">2007 to 2008</td><td rowspan="4">Suncor Mine Dump 9 (MD9)</td><td>Fall</td><td rowspan="3">no observations</td><td rowspan="4">Suncor (2008)</td></tr>
<tr><td>Winter</td></tr>
<tr><td>Spring</td></tr>
<tr><td>Summer</td><td>0.05</td></tr>
</table>

Table E-24 Fisher Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.17	Unpublished Data
		Winter	0.18	
		Spring	0.08	
		Summer	no observations	
2008	Enerplus Kirby Project	Fall	0.17	Enerplus (2008)
		Winter	0.33	
		Spring	no observations	
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter		
		Spring	0.13	
		Summer	0.07	
2008 to 2010	Dover Commercial Project	Fall	0.05	Dover OPCO (2010)
		Winter	0.10	
		Spring	0.10	
		Summer	no observations	
2005	CPC Surmont Project	Fall	0.17	Unpublished Data
		Winter	0.13	
		Spring	0.04	
		Summer	0.08	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	no observations	Cenovus (2011)
		Winter	0.10	
		Spring	0.13	
		Summer	0.07	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter	0.29	
		Spring	0.26	
		Summer	0.17	

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-25 Marten Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [a]	Reference
2005 to 2007	Suncor Voyageur South	Fall	0.11	Suncor (2007)
		Winter	0.10	
		Spring	0.30	
		Summer	no observations	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter		
		Spring		
		Summer		
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	0.16	Canadian Natural (2007)
		Winter	no observations	
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring	0.63	
		Summer	0.63	
		Pierre River Mine		
		Fall	0.64	
		Winter	0.28	
		Spring	0.31	
		Summer	0.41	
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	no observations	MEG (2008)
		Winter		
		Spring		
		Summer	0.05	
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter	1.00	
		Spring	no observations	
		Summer		
2007 to 2008	Total Joslyn Mine Expansion	Fall	0.25	Unpublished Data
		Winter	0.18	
		Spring	0.08	
		Summer	no observations	

Table E-25 Marten Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter		
		Spring	0.07	
		Summer	no observations	
2008 to 2010	Dover Commercial Project	Fall	0.05	Dover OPCO (2010)
		Winter	0.10	
		Spring	0.05	
		Summer	0.05	
2005	CPC Surmont Project	Fall	0.13	Unpublished Data
		Winter	0.13	
		Spring	no observations	
		Summer	0.08	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	0.43	Cenovus (2011)
		Winter	0.47	
		Spring	0.30	
		Summer	0.17	
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	0.04	Canadian Natural (2011)
		Winter	no observations	
		Spring		
		Summer	0.04	

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-26 Weasel Survey Results Within the Region

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	weasel species	1.92 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	weasel species	1.47	preferred aspen-willow/alder, treed black spruce and tall shrub; avoided black spruce-willow and disturbed	Penner (1976)
1980	Canstar Project 80	weasel species	1.14	preferred black spruce muskeg; avoided jack pine and open muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	weasel species	0.27	preferred willow; avoided balsam poplar, jack pine, white spruce and riparian white spruce	Westworth and Brusnyk (1982)
1985	OSLO [(a)]	weasel species	no overall track count/km-track day provided	low densities in forested and unforested habitats, high use of logged areas	Duncan et al. (1986)
1995	Solv-Ex	weasel species	1.75	most tracks in black spruce and jack pine	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	weasel species	1.22	preferred black spruce-tamarack, open tamarack bog birch and cleared peatland; avoided aspen forest, mixedwood forest, mixed coniferous, fen wetlands, willow wetlands and riparian white spruce	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	weasel species	5.16 in December 0.83 in February	preferred black spruce-tamarack, open black spruce, open tamarack/fen and fen; avoided closed jack pine, closed mixedwood, wetlands shrub complex, disturbed and shoreline	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	weasel species	1.12	preferred closed mixedwood-white spruce dominant and closed mixedwood; avoided closed balsam poplar, open and closed aspen, closed mixed coniferous	Golder (1997a,b)

Table E-26 Weasel Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1997	Suncor Winter Wildlife	weasel species	0.80 in January 0.78 in February	January: avoided Shrub, BTNN and WONN February: preferred BTNN; avoided a1, d1, d2, d3 and h1	Golder (1998a,b)
1997	Suncor Winter Wildlife	weasel species	0.71 in January 0.48 in February 0.00 in March	January: prefer riparian avoid escarpment February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	weasel species	0.2	most in tamarack forest and riparian willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	weasel species	1.0	preferred FONS; avoided a1, b1, b2, d1, d2 and d3	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	weasel species	0.16 in reclaimed 1.75 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	weasel species	mean: 2.1	most common in h1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	weasel species	0.31	preferred FTNN; avoided a1, b1, d1, d3, e2 and BTNN	Golder (2000a)
2000	Albian Sands Lease 13 West	weasel species	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	weasel species	0.40 in Lease 86/17 0.78 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	weasel species	0.46	tracks mainly were observed in the FTNN, d2 and h1 ecosite phase/wetlands types	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	weasel species	no observations	n/a	Golder (2001a)
2000	Gulf Surmont In-situ Oil Sands Project	weasel species	0.1	found in b1, b2, d2, e3, f1, f2, g1, h1 and FTNN	Gulf (2001)
2001	Rio Alto Kirby Project	weasel species	0.38	no preference, most commonly observed in g1 and FTNN; one set of tracks each observed in STNN and disturbed	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	weasel species	0.48	observed in c1, g1 and BTNN ecosite phase/wetlands types	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	weasel species	0.67	observed in d2, FONS, FTNN, h1, SONS and STNN; preferred FTNN, avoided d2 and STNN	Golder (2002a)

Table E-26 Weasel Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2001	Canadian Natural Horizon Project	weasel species	0.65	observed in b3, d1, d2, d3, e1, e3, g1, BTNN, FTNN, FONG, FONS, STNN, SONS, and cutblock; avoided e3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	weasel species	1.00	observed in FONS, FTNN, FONG and d2; preference for FONS and FTNN; avoided d2	Golder (2003c)
2002	Devon Jackfish Project	weasel species	0.9	highest track densities in k3	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	weasel species	0.69	most observations in FTNN	Golder (2004a)
2004	MEG Christina Lake Regional Project	weasel species	0.35	no preferences; most abundant in b4 and b2	MEG (2005)
2004	Suncor Monitoring Five Year Report	weasel species	0.53	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	weasel species	0.70 0.59	preference for treed wetlands most abundant in b3 and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	weasel species	0.52	most observations in c1, g1, and BTNN; preference for c1 and avoidance of WONN	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	weasel species	0.06	observed in j1 and d1	Devon (2006)
2005 to 2006	Long Lake South Project	weasel species	0.1	most observed in f2	OPTI/Nexen (2006)
2005 to 2007	Suncor Voyageur South	weasel species	1.59	preference for ROW	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	weasel species	1.78	preference for FONS, FTNN avoidance b3, b4, burn, d2, g1	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	weasel species	Jackpine - 0.61 Pierre River - 0.21	preference for e3, FTNN and g1 b1, c1, d1, d2, cutlines and roads were used significantly less than expected	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	weasel species	0.06	most observed in d3, i2	North American (2007)
2007 to 2008	MEG Christina Lake Regional Project Phase 3	weasel species	1.42	preferred FTNN	MEG (2008)
2007 to 2008	Suncor Mine Dump 9 (MD9)	weasel species	2.78	preference for ROW	Suncor (2008)

Table E-26 Weasel Survey Results Within the Region (continued)

Year	Project	Species	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2008	Total Joslyn Mine Expansion	ermine least	0.32 0.08	highest track density recorded in j1, f3, and b4 highest track density recorded in b4 and i2	Unpublished Data
2008	Enerplus Kirby Project	weasel species	0.33	observed in d2, BONS, shrub, and a disturbed road	Enerplus (2008)
2008	West Ells SAGD Project	weasel species	0.8	most observations in white spruce	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	weasel species	0.38 in c1 0.70 in d3 0.57 in e1 0.09 in i1 0.21 in j1 1.33 in k2	most observations in k2 and d3	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	weasel species	0.48	mostly recorded in SONS, FONS, FTNN and BTNN, also observed in b1, b3, d1, d2, g1 and disturbed-linear	Cenovus (2010)
2008 to 2010	Dover Commercial Project	weasel species	0.21	most tracks observed in BTNN; highest density in STNN	Dover OPCO (2010)
2011	CPC Surmont Project	weasel species	0.86	highest track density observed in burn, SONS and shrubland	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	weasel species	2.15	primarily in BTNN and FTNN	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	weasel species	0.37	highest track densities in BTNN, FONS, BONS and SONS	Present Study

[a] OSLO = Other Six Lease Owners.

n/a = Not applicable.

Table E-27 Weasel Photographic Bait Station Results Within the Region

Year	Project	Season	Occurrence Rate [(a)]	Reference
2005 to 2007	Suncor Voyageur South	Fall	0.11	Suncor (2007)
		Winter	no observations	
		Spring		
		Summer		
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	Fall	no observations	EnCana (2009)
		Winter		
		Spring		
		Summer		
2006 to 2007	Canadian Natural Resources Limited Kirby In-Situ Oil Sands Project	Fall	no observations	Canadian Natural (2007)
		Winter		
		Spring		
		Summer		
2006 to 2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine Mine Expansion		Shell (2007)
		Fall	no observations	
		Winter		
		Spring		
		Summer		
		Pierre River Mine		
		Fall	no observations	
		Winter		
		Spring		
		Summer		
2007 to 2008	MEG Christina Lake Regional Project Phase 3	Fall	no observations	MEG (2008)
		Winter	0.05	
		Spring	no observations	
		Summer		
2007 to 2008	Suncor Mine Dump 9 (MD9)	Fall	no observations	Suncor (2008)
		Winter		
		Spring		
		Summer		

Table E-27 Weasel Photographic Bait Station Results Within the Region (continued)

Year	Project	Season	Occurrence Rate [a]	Reference
2007 to 2008	Total Joslyn Mine Expansion	Fall	no observations	Unpublished Data
		Winter		
		Spring		
		Summer		
2008	Enerplus Kirby Project	Fall	no observations	Enerplus (2008)
		Winter		
		Spring		
		Summer		
2009 to 2010	Cenovus Narrows Lake Project	Fall	no observations	Cenovus (2010)
		Winter		
		Spring		
		Summer		
2008 to 2010	Dover Commercial Project	Fall	no observations	Dover OPCO (2010)
		Winter		
		Spring		
		Summer		
2005	CPC Surmont Project	Fall	0.12	Unpublished Data
		Winter	0.08	
		Spring	no observations	
		Summer	0.08	
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	Fall	no observations	Cenovus (2011)
		Winter	0.03	
		Spring	no observations	
		Summer		
2006-2008 and 2011	Canadian Natural Kirby Expansion	Fall	no observations	Canadian Natural (2011)
		Winter		
		Spring		
		Summer		

[a] Occurrence Rate = proportion of stations where a particular species was photographed.

Table E-28 Beaver Survey Results Within the Region

Year	Project	Results	Reference
1970 to 1975	traplines	12.9 animals/ 100 km^2 trapped	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.14 to 1.0/km river or creek; 1.9/km^2	Penner (1976)
1978	AOSERP[(a)]	0.32 active lodges/km of stream and 0.14 active lodges/km of lakeshore	Searing (1979)
1978	AOSERP[(a)]	0.40 active lodges/km of stream	Gilbert et al. (1979), as reported in Conor Pacific (1998)
1978	Syncrude	0.32 food caches/km^2 0.26 active lodges/km^2	Westworth (1978), as reported in Conor Pacific (1998)
1979	Syncrude	0.29 food caches/km^2 0.23 active lodges/km^2	Westworth (1979), as reported in Conor Pacific (1998)
1980	Canstar Project 80	0.11 active lodges/km^2 or 0.16/km Muskeg River	Skinner and Westworth (1981)
1981	Canstar Lease	0.42 active lodges/km^2	Westworth and Brusnyk (1982)
1983	AOSERP	0.81 food caches/km^2 0.94 active lodges/km^2	Green (1980), as reported in Conor Pacific (1998)
1984	Syncrude	0.44 food caches/km^2	Pauls (1984), as reported in Conor Pacific (1998)
1985	OSLO[(b)]	0.32 food caches/km^2	Salter and Duncan (1986)
1985	BP Resources	0.2 active lodges/km in wetlands	BP Resources et al. (1985)
1985	BP Resources	0.3 active lodges/km for shoreline 0.6 active lodges/km for creeks	Young and Bjornson (1985)
1986	Syncrude	0.52 food caches/km^2	Pauls and Arner (1987), as reported in Conor Pacific (1998)
1988	Syncrude	0.42 food caches/km^2	Pauls (1989), as reported in Conor Pacific (1998)
1991	Syncrude	0.46 food caches/km^2	Pauls (1991), as reported in Conor Pacific (1998)
1996	Aurora Mine	0.09 active lodge and food caches/km^2 and 0.57 active lodge and food caches /km^2 on the previous Alsands Site	Fort McKay Environmental Services Ltd. (1996)
1998	Mobil Lease 36	0.37 active lodges/km^2	Golder (1999b)
1999	OPTI Long Lake Project	0.61 active lodges/km^2 or 1.6 active lodges/km	OPTI (2000)
2001	Rio Alto Kirby Project	0.02 active lodges/ha of lake 0.02 inactive lodges/ha of lake 0.00 active lodges/km of tributary 1.14 inactive lodges/km of tributary	Rio Alto (2002)

Table E-28 Beaver Survey Results Within the Region (continued)

Year	Project	Results	Reference
2001	Petro-Canada Meadow Creek Project	0.08 active lodges/ha of lake 0.20 active lodges/km of drainage	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.69 active lodges/km of tributary 0.66 inactive lodges/km of tributary	Golder (2002a)
2001	Canadian Natural Horizon Project	0.05 active lodges/ha of lake 0.08 inactive lodges/ha of lake 1.17 active lodges/km of tributary 1.27 inactive lodges/km of tributary	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.78 active lodges/km of tributary 1.17 inactive lodges/km of tributary	Golder (2003c)
2003	Cenovus – Christina Lake Thermal Project	3 incidental sightings during other surveys	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.84 food caches/km^2 of lake (0.008/ha) 1.03 active lodges/km^2 of lake (0.010/ha) 0.21 food caches/km of stream 0.17 active lodges/km of stream	MEG (2005)
2004	Suncor Voyageur	North Steepbank: 0.34 active lodges/km of tributary 0.45 inactive lodges/km of tributary Upgrader: 1.4 active lodges/km of tributary 0.2 inactive lodges/km of tributary	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	3 incidental observations of individuals or sign during other surveys	Canadian Natural (2006)
2006	Suncor Voyageur South	0.16 active lodges/km of watercourse 0.22 inactive lodges/km of watercourse 0.02 active lodges/lake 0.01 inactive lodges/lake	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1 F and 1G	0.03 active lodges/km of stream 0.04 active lodges/lake	EnCana (2009)

Table E-28 Beaver Survey Results Within the Region (continued)

Year	Project	Results	Reference
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	0.06 active lodges/ha of lake (Jackpine, 2005) 0.62 active lodges lodges/km of watercourse (Jackpine, 2005) 0.03 active lodges/ha of lake (Pierre River, 2005) no active lodges/km of watercourse (Pierre River, 2005) 0.02 active lodges/ha of lake (Pierre River, 2006) 0.53 active lodges/km of watercourse (Pierre River, 2006)	Shell (2007)
2007	Cenovus Narrows Lake Project	0.47 active lodges/km of waterways and shoreline 0.03 lodges/km of lake	Cenovus (2010)
2008	MEG Christina Lake Regional Project Phase 3	0.17 active lodges/km of watercourse 1.03 active lodges/km of waterbodies	MEG (2008)
2008	Suncor Mine Dump 9 (MD9)	0.61 lodges/km of watercourse 0.53 active lodges/km of watercourse no active or inactive lodges on lakes	Suncor (2008)
2008	Total Joslyn Mine Expansion	0.75 active lodges/km of watercourse	Unpublished Data
2007	Enerplus Kirby Project	0.36 active lodges/km of stream 0.02 active lodges/km lake	Enerplus (2008)
2008	West Ells SAGD Project	18 lodges and 3 food caches identified	Sunshine (2010)
2009	McKay SAGD Pilot Project	6 lodges and 1 food cache. Beaver lodge density estimated at 0.29/km^2	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	0.18 active lodges/km of watercourse	Dover OPCO (2010)
2010	CPC Surmont Project	0.28 active lodges/km of waterways/shoreline and 0.36 active lodges/ha of lake;	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.35 active lodge/km of watercourse 0.02 active lodge/ha of lake/pond	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	0.41 active lodges/km of waterways and shoreline 0.01 active lodges/ha of lake/pond	Canadian Natural (2011)

(a) AOSERP = Alberta Oil Sands Environmental Research Program.

(b) OSLO = Other Six Lease Owners.

Table E-29 Muskrat Survey Results Within the Region

Year	Project	Results	Reference
1970 to 1975	traplines	6.13 animals/ 100 km^2 trapped	Boyd (1977)
1975 to 1976	Syncrude Lease 17	estimate of 0.3 - 2.5 muskrats/ha	Penner (1976)
1980	Canstar Project 80	0.03 houses/km^2 (6 houses observed within the 176 km^2 study area)	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.02 houses/km^2 (6 houses in 387 km^2 study area)	Westworth and Brusnyk (1982)
1983	Syncrude	39 muskrat houses, common on Ruth Lake and Horseshoe Lake	Murray and Pauls (1983)
1984	Syncrude	48 muskrat houses recorded	Pauls (1984)
1986	Syncrude	25 muskrat lodges recorded, most on Horseshoe Lake	Pauls and Arner (1987)
1989	Syncrude	64 houses recorded, most on Horseshoe Lake	Pauls (1989)
1990	Syncrude	no observations	Pauls (1991)
1991	Syncrude	low number observed	Pauls (1991)
1996	Aurora Mine	no observations	Fort McKay Environmental Services Ltd. (1996)
1997	Suncor Winter Wildlife	no observations	Golder (1998a,b)
1997	Mobil Lease 36	0.21 houses/km^2 and 0.84 feeding platforms/km^2	URSUS and Komex (1997)
2000	OPTI Long Lake Project	0.54 push ups/km^2	OPTI (2000)
2000	Canadian Natural PAW Project	muskrat houses were observed in shrubby fen and shallow open water with wetlands	Canadian Natural (2000)
2001	Rio Alto Kirby Project	0.01 push-ups/ha of lake 0.29 push-ups//km of tributary	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.00 push-ups/km^2	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	Golder (2002a)
2001	Canadian Natural Horizon Project	0.02 push-ups/ha of lake 0.07 push-ups//km of tributary	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	Golder (2003c)
2004	MEG Christina Lake Regional Project	2.06 push-ups/km of tributary	MEG (2005)
2004	Suncor Voyageur	no observations	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	2 incidental observations of individuals during other surveys	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	no observations	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.01 tracks/km-track day; most observed in j2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1 lodge and 12 push-ups observed	Golder (2007a)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	1 lodge and no push-ups observed	EnCana (2009)

Table E-29 Muskrat Survey Results Within the Region (continued)

Year	Project	Results	Reference
2007	Shell Jackpine Mine Expansion and Pierre River Mining areas	no observations	Golder (2007b)
2008	MEG Christina Lake Regional Project Phase 3	2.06 push-ups/km^2	MEG (2008)
2008	Suncor Millennium MD9 Update	no observations	Unpublished data
2008	Total Joslyn Mine Expansion	no observations	Unpublished data
2008	Enerplus Kirby Project	no observations	Enerplus (2008)
2007	Cenovus Narrows Lake Project	0.02 houses/ha of lake and no push-ups	Cenovus (2010)
2008	West Ells SAGD Project	not surveyed	Sunshine (2010)
2009	McKay SAGD Pilot Project	not surveyed	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	not observed	Dover OPCO (2010)
2010	CPC Surmont Project	no observations	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.01 houses/ha lake	Cenovus (2011)
2011	Canadian Natural Kirby Expansion	0.01 push-ups/ha of lake/pond 0.06 push-ups//km of waterways and shoreline	Canadian Natural (2011)

Table E-30 River Otter Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	0.12 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.0007	n/a	Penner (1976)
1980	Canstar Project 80	0.01(all) 0.06 (riparian)	only in riparian habitat	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.0005	n/a	Westworth and Brusnyk (1982)
1985	BP Resources	general observations	n/a	BP Resources et al. (1985)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.02	only in riparian shrub, fen and willow wetlands	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.01	only in shoreline	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	0.01	only in riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.0 in reclaimed 0.04 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 0.6	most common in FONG	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	n/a	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	0.02	found in FTNN and SONS	Golder (2000a)
2000	Albian Sands Lease 13 West	0.0 in upland 0.11 in riparian	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.06 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	1 set of old tracks observed	mixedwood	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	mean observations: 0.07 in January 1999/2000 0.10 in January 2000/2001 0.01 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors, however, the animal's ecology suggests a preference for riparian areas	Golder (2001a)

Table E-30 River Otter Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2001	Rio Alto Kirby Project	0.02	one set of tracks observed in WONN	Rio Alto (2002)
2000	Gulf Surmont In-situ Oil Sands Project	0.1	found in F1 and FONG	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	0.05	tracks observed in d2 and e1	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	0.02	observed in SONS and WONN	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003c)
2002	Devon Jackfish Project	1 observed track in g1	n/a	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	1 set of tracks observed incidentally	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	2 incidental observations	stream/SONS	MEG (2005)
2004	Suncor Voyageur	1 set of tracks observed no observations	n/a	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	no observations	n/a	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.01	most observed in e3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	no observations	n/a	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	no observations	n/a	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 0.02 Pierre River - 0.01	observed in FTNN, riparian, SONS observed in BTNN, SONS, WONN	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	0.008	observed in h1, i1	North American (2007)
2008	MEG Christina Lake Regional Project Phase 3	2 incidental observations	observed at a watercourse surrounded by SONS	MEG (2008)
2008	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2008	Total Joslyn Mine Expansion	no observations	n/a	Unpublished Data

Table E-30 River Otter Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2008	Enerplus Kirby Project	no observations	n/a	Enerplus (2008)
2007 to 2008	MacKay River Commercial Project	4 incidental observations	2 in shrub/meadow, 1 in fen, 1 in conifer	AOSC (2009)
2008	West Ells SAGD Project	no observations	n/a	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	no observations	n/a	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	no observations	n/a	Cenovus (2010)
2008 to 2010	Dover Commercial Project	two detected incidentally	n/a	Dover OPCO (2010)
2011	CPC Surmont Project	0.02	h1, SONS, d2	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	no observations	n/a	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	<0.01	one set of tracks on ice	Present Study

n/a = Not applicable.

Table E-31 Mink Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	2.26 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.1	most in riparian, aspen-willow and deciduous dominated mixedwood[(a)]	Penner (1976)
1980	Canstar Project 80	0.10	preferred riparian shrub; avoided aspen, jack pine, black spruce muskeg and open muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.10	preferred willow wetlands; avoided aspen, balsam poplar, mixed wood, jack pine, white spruce and black spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.22 in January	preferred riparian shrub; avoided aspen and mixedwood forest, jack pine, mixed coniferous, black spruce-tamarack, fen and willow wetlands, riparian balsam poplar and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.02	most in wetlands shrub complex	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	0.03	only in riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.59 in January no observations in February	January: avoided a1, d3, d1, d2, h1, FTNN, BTNN and WONN	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	only in riparian willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.01	only in FONS and FTNN/FFNN	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.13 in reclaimed 0.19 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 0.4	most common in FONG	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000a)
2000	Albian Sands Lease 13 West	0.00 in upland 0.07 in riparian	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.02 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.02	tracks observed in wooded fen (FTNN) wetlands type	OPTI (2000)

Table E-31 Mink Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1999-2001	Albian Sands Lease 13 West	mean densities: 0.05 in January 1999/2000 0.00 in January 2000/2001 0.15 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors; however, animal's ecology suggests a preference for riparian areas	Golder (2001a)
2000	Gulf Surmont In-situ Oil Sands Project	0.1	found in riparian communities (f1 andf2) and FONG	Gulf (2001)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.02	observed in e1	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	one set of tracks observed	observed in e3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003c)
2002	Devon Jackfish Project	n/a	8 tracks encountered, 6 of which occurred in k3 associated with lower order streams	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	no observations	n/a	MEG (2005)
2004	Suncor Voyageur	0.09 no observations	preference for shrubby wetland n/a	Golder (2005)
2004-2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	no observations	n/a	Devon (2006)
2005-2006	OPTI/Nexen Long Lake South Project	0.01	most observed in k2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	no observations	n/a	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.01	e2	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	no observations	n/a	Shell (2007)

Table E-31 Mink Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2007	StatoilHydro Kai Kos Dehseh	0.01	most observed in j3	North American (2007)
2008	MEG Christina Lake Regional Project Phase 3	no observations	n/a	MEG (2008)
2008	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2008	Total Joslyn Mine Expansion	no observations	n/a	Unpublished Data
2008	Enerplus Kirby Project	no observations	n/a	Enerplus (2008)
2008	West Ells SAGD Project	no observations	n/a	Sunshine (2010)
2008-2009	McKay SAGD Pilot Project	no observations	n/a	Southern Pacific (2009)
2009-2010	Cenovus Narrows Lake Project	no observations	n/a	Cenovus (2010)
2008-2010	Dover Commercial Project	no observations	n/a	Dover OPCO (2010)
2011	CPC Surmont Project	0.01	SONS, d1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	no observations	n/a	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	no observations	n/a	Present Study

[a] Not statistically significant.

n/a = Not applicable.

Table E-32 Snowshoe Hare Survey Results Within the Region

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
1975 to 1976	Syncrude Lease 17	2.94	preferred aspen-willow/alder, mixedwood, forested black spruce and tall shrub; avoided aspen-balsam poplar, jack pine, treed black spruce, black spruce-willow, dwarf birch-tamarack, riparian and disturbed	Penner (1976)
1980	Canstar Project 80	21.15	preferred mixedwood, black spruce-muskeg and riparian white spruce; avoided aspen, jack pine and open muskeg	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	76.2	preferred aspen and balsam poplar; avoided mixedwood, white spruce, black spruce, willow, fen, willow wetlands and riparian aspen	Westworth and Brusnyk (1982)
1986	OSLO[(a)]	no overall track count/ km-track day provided	track densities were greatest in aspen-dominated, pine dominated mixed and spruce forests	Duncan et al. (1986)
1995	Solv-Ex	14.69	most tracks in aspen-white spruce and white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	3.53 in January	preferred mixed coniferous and black spruce-tamarack; avoided cleared aspen, aspen and mixedwood forests, jack pine, open tamarack bog-birch, fen and willow wetlands, riparian balsam poplar and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	4.14 in December 0.49 in February	preferred closed jack pine, closed mixedwood, closed mixed coniferous-black spruce dominant and open black spruce; avoided closed white spruce, closed deciduous, black spruce tamarack, open tamarack/fen, wetlands shrub complex, disturbed, shoreline and fen	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	22.36	preferred closed jack pine, closed white spruce, closed balsam poplar, closed mixed conifer-black spruce dominant, closed mixedwood-white spruce dominant and closed black spruce bog; avoided wetlands shrub complex, open black spruce bog, riparian shrub dominant, open and closed aspen	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.98 in January 5.80 in February	January: preferred d2; avoided a1, d3, d1, h1, Shrub, BTNN and WONN February: preferred d2; avoided d1, d3, FTNN and BTNN	Golder (1998a,b)
1997	Suncor Winter Wildlife	12.41 in January 15.98 in February 3.53 in March	January: preferred upland avoided riparian February: preferred upland avoided riparian and escarpment March: preferred upland avoided riparian	Golder (1998a,b)
1997	Mobil Lease 36	3.99	most in closed canopy black spruce, white spruce, black spruce-tamarack bog and white spruce-aspen mixedwood; avoided aspen stands	URSUS and Komex (1997)
1998	Suncor Firebag Project	8.96	preferred b4 and BTNN/BFNN; avoided a1, b2 and FONS	Suncor (2000)

Table E-32 Snowshoe Hare Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
1998 to 1999	Suncor Wildlife Monitoring	10.41 in reclaimed 23.29 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 204.7	most common in h1	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	found in aspen, jack pine/aspen, shrubby fen, treed fen, aspen/white spruce, black spruce/jack pine	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	10.13	preferred d2, g1 and FTNN; avoided b1, d1, e1 and SONS	Golder (2000a)
2000	Suncor Wildlife Monitoring	10.85 in Lease 86/17 17.78 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	90.90	preferred d2, d3, SONS and STNN; avoided e1, FONS, h1 and shrub	OPTI (2000)
2000	Gulf Surmont In-situ Oil Sands Project	77.4	found in all habitats except e1. Highest track counts were found in b3 and a1	Gulf (2001)
2001	Rio Alto Kirby Project	112.5	preferred b1, d3, e2, g1, STNN; avoided b3, d1, d2, FONS, MONG, SONS, WONN and disturbed	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	48.77	preferred b3, c1, f1, g1, SONS; avoided b2, d1, d2, BTNN, FONS, FTNN, MONG, STNN and cutlines	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	88.26	preferred b4, c1, FTNN, g1, h1, SONS and STNN	Golder (2002a)
2001	Canadian Natural Horizon Project	44.57	preferred b1, b3, d1, g1, h1, BTNN, FTNN, FONS, STNN, and seismic line; avoided b4, d2, e1, e3, FONG, MONG, cutblock and road	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	19.37	observed in d2, FTNN, e3, FONS, BTNN, h1, e2, and disturbed (cutblock); significant preference for d2 and e3; avoided e2, BTNN, FONG, FONS, cutline/disturbance	Golder (2003c)
2002	Devon Jackfish Project	23.2	highest track densities in a1,c1,i2,k1,h1,g1 and j1	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	0.67	observed in BTNN,d2 and g1	Golder (2004a)
2004	MEG Christina Lake Regional Project	13.3	Preference for a1, c1, d2, d3, g1; avoided b2, d1, FONS, FTNN, BTNN, SONS and WONN	MEG (2005)
2004	Suncor Monitoring Five Year Report	12.87	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	10.10 0.71	preference for treed wetlands and black and white spruce forests preference for d2 and BTNN	Golder (2005)

Table E-32 Snowshoe Hare Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
2004 to 2005	Canadian Natural Primrose East Expansion	4.37	preferred c1, d2 , d3, and g1; avoided FONS, FTNN, BTNN, SONS, and WONN	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	2.2	observed in j1, c1, burn area, k2, and k3	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	8.4	most observed in e3	OPTI/Nexen (2006)
2005-2007	Suncor Voyageur South	4.21	primarily observed in BTNN, d2, FTNN, g1, STNN	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phase 1E, 1F and 1G	5.76	primarily observed in BTNN, FTNN, FONS	EnCana (2009)
2005-2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine -16.99 Pierre River - 27.45	primarily observed in b4, g2 and STNN primarily observed in b4, BFNN, g2, FTNN	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	3.8	most observed in c1, a1, j3	North American (2007)
2007-2008	MEG Christina Lake Regional Project Phase 3	10.4	preferred a1, b3, b4, BFNN, c1, and e1	MEG (2008)
2007-2008	Suncor Mine Dump 9 (MD9)	5.52	primarily observed in BTNN, d2, FTNN, g1, STNN	Suncor (2008)
2007-2008	Total Joslyn Mine Expansion	15.90	primarily observed in f3, g1, h1, i1, j1, k1	Unpublished Data
2008	Enerplus Kirby Project	6.97	primarily observed in a1, d1, c1, and g1,	Enerplus (2008)
2007-2008	MacKay River Commercial Project	44.36	primarily in d1 and d2, but observed in all habitat types	AOSC (2009)
2008	West Ells SAGD Project	31.9	primarily in mixed coniferous and white spruce	Sunshine (2010)
2009-2010	Cenovus Narrows Lake Project	41.86	primarily observed in b2, but recorded in all sampled habitats except non-linear disturbance	Cenovus (2010)
2008-2010	Dover Commercial Project	44.88	most tracks observed in BTNN; highest density in e1	Dover OPCO (2010)
2011	CPC Surmont Project	63.84	highest track density observed in d1, h1, STNN, riparian and shrubland	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	32.84	highest track density observed in SONS and c1	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	44.68	highest track density observed in b1, b2, e2, d3 and h1	Present Study

[(a)] OSLO = Other Six Lease Owners.

n/a = Not applicable.

Table E-33 Red Squirrel Survey Results Within the Region

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1970 to 1975	traplines	49.6 animals/ 100 km^2 trapped	n/a	Boyd (1977)
1975 to 1976	Syncrude Lease 17	2.33; 1.19 squirrels/ha based on a midden study	preferred mixedwood, white spruce, jack pine and forested black spruce; avoided aspen, black spruce-willow, tall shrub, dwarf birch-tamarack, riparian and disturbed	Penner (1976)
1980	Canstar Project 80	2.08	preferred aspen, mixedwood, jack pine and riparian white spruce; avoided black spruce-muskeg, open muskeg and riparian shrub	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	1.59 in February	preferred mixedwood avoided aspen, balsam poplar, willow, fen, willow wetlands and riparian aspen	Westworth and Brusnyk (1982)
1986	OSLO[(a)]	no overall track count/km-track day provided	track densities were greatest in pine, spruce and mixedwood forests and in bogs, no tracks were observed in aspen forest, shrubland and fens	Duncan et al. (1986)
1995	Solv-Ex	6.89	most in white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.63 in January	preferred mixed coniferous and riparian white spruce; avoided cleared aspen, aspen forest, open tamarack-bog birch, fen and willow wetlands, riparian balsam poplar and shrub and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	2.78 in December 0.42 in February	preferred closed jack pine and closed mixed coniferous-black spruce dominant; avoided black spruce-tamarack, open black spruce, open tamarack fen, wetlands shrub complex, disturbed, shoreline and fen	Westworth, Brusnyk and Associates (1996c)
1997	Shell Muskeg River Mine	5.65	preferred closed white spruce, closed mixedwood-white spruce dominant; avoided closed mixed wood, closed mixed coniferous-black spruce dominant, open and closed fen	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.35 January 0.24 in February	January: preferred d2; avoided a1, h1, Shrub, FTNN, BTNN and WONN February: no preferences	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.62 in January 3.18 in February 9.86 in March	January: preferred riparian; avoided upland February and March: preferred escarpment; avoided upland	Golder (1998a,b)
1997	Mobil Lease 36	2.62	most in white spruce-aspen mixedwood, jack pine, white spruce, black spruce-aspen and black spruce-tamarack	URSUS and Komex (1997)
1998	Suncor Firebag Project	1.00	preferred b4, c1 and BTNN/BFNN; avoided b2, g1, FONS and FTNN/FFNN	Suncor (2000)

Table E-33 Red Squirrel Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
1998 to 1999	Suncor Wildlife Monitoring	2.77 in reclaimed 15.64 in riparian area beside disturbance	n/a	Golder (1999a)
2000	ATCO Pipeline	mean: 13.8	most common in d3, also common in h1	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	found in poor fen/bog, treed fen, black spruce/jack pine, aspen/white spruce and white spruce/black spruce	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	0.31	preferred BTNN; avoided d1, e1, g1, Shrub and SONS	Golder (2000a)
2000	Suncor Wildlife Monitoring	0.23 in Lease 86/17 0.30 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	1.25	preferred d3; avoided d1, FTNN and shrub	OPTI (2000)
2001	Rio Alto Kirby Project	3.70	preferred d2 and g1; avoided FONS and FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	2.50	preferred d2; avoided BTNN and FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.47	observed in a1, b4, c1, d2, d3, FTNN, g1 and h1; observed incidentally in a1, b1, b3, c1, d1, d2 and FONS	Golder (2002a)
2001	Canadian Natural Horizon Project	2.31	observed in b1, b3, d1, d2, d3, e1, e2, e3, h1, BTNN, FTNN, STNN, burn and cutblock; avoided d1, g1, BTNN, FTNN, FONS, STNN, SONS, burn and cutblock	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	3.57	observed in d2, e3, FTNN, e2 and BTNN; preference for e3; avoided BTNN and FTNN	Golder (2003c)
2002	Devon Jackfish Project	9.6	highest track densities in d3,e2 and h1	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	6 incidental observations during other surveys on the LSA	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	4.57	preferred d2, d3; avoided FTNN, FONS, SONS, WONN	MEG (2005)
2004	Suncor Voyageur	1.94 1.26	preference for mixedwood and white spruce forests observed in a1, b1, b3, c1, d2, g1, BTNN, FTNN, FONG, disturbed – vegetated	Golder (2005)
2000	Gulf Surmont In-situ Oil Sands Project	7.6	most in e3 and a1	Gulf (2001)
2004 to 2005	Canadian Natural Primrose East Expansion	5.81	preferred c1, d2, and d3; avoided FTNN, BTNN, FONS, SONS, and WONN	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	1.0	observed in i1, h1, b4, d3, and b1	Devon (2006)

Table E-33 Red Squirrel Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day unless otherwise noted]	Habitat	Reference
2005 to 2006	OPTI/Nexen Long Lake South Project	3.3	most observed in f3	OPTI/Nexen (2006)
2005-2007	Suncor Voyageur South	1.65	observed primarily in d2, d3, g1, e2, h1	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	4.63	observed primarily in BTNN, d1, FTNN, FONS	EnCana (2009)
2005-2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 1.68 Pierre River - 4.74	primarily observed in b1, b4, e3 primarily observed in c1, d3, e1, e2, f2, f3	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	3.2	most observed in d3	North American (2007)
2007-2008	MEG Christina Lake Regional Project Phase 3	1.75	preference was shown for g1	MEG (2008)
2007-2008	Suncor Mine Dump 9 (MD9)	9.54	observed primarily in d2, FTNN, BTNN, g1	Suncor (2008)
2007-2008	Total Joslyn Mine Expansion	1.32	observed primarily in b3, and g1	Unpublished Data
2008	Enerplus Kirby Project	1.71	primarily observed in a1 and disturbed cutline	Enerplus (2008)
2008	West Ells SAGD Project	18.9	primarily in white spruce and mixed coniferous	Sunshine (2010)
2008-2009	McKay SAGD Pilot Project	0.00-7.33 depending on habitat	primarily found in g1 and c1	Southern Pacific (2009)
2009- 2010	Cenovus Narrows Lake Project	6.35	observed primarily in b2, b3 and h1, secondarily in b1, c1, d1, d2, d3, g1, BTNN, FONS, FTNN, SONS, STNN and disturbed-linear	Cenovus (2010)
2008-2010	Dover Commercial Project	1.52	most tracks observed in BTNN; highest density in STNN	Dover OPCO (2010)
2011	CPC Surmont Project	1.90	highest track density observed in b1, d3, e3, f2 and h1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	1.92	highest track density observed in c1	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	3.45	highest track density observed in a1, b4, d3 and h1	Present Study

[(a)] OSLO = Other Six Lease Owners.

n/a = Not applicable.

Table E-34 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta

Year	Project	Activity Results	Bat Captures	Habitat	Reference
1993 to 1994	MSc Research (Lac La Biche, AB)	1933 passes (passes/hr n/a) *Myotis* spp.[(a)], silver-haired, big brown and hoary bats	99 bats (bat /net-night n/a) little brown (80), northern myotis (1), silver-haired (17) and hoary (1) bats	captured and detected primarily in old and mature aspen mixedwood forest	Crampton and Barclay (1998)
1999 to 2000	MSc Research (near Peace River, AB)	2193 passes (1.6 passes/hr): little brown, northern long-eared and silver-haired bats	56 bats (0.31 /net-night): little brown (41), northern myotis (13) and silver-haired (2) bats	captured in aspen dominant and white spruce dominant forest in cutlines, above puddles and ponds; detected in aspen dominant, white spruce dominant and mixedwood forests within open patches and closed canopies	Patriquin (2001)
2000	Gulf Surmont Supplemental Wildlife Surveys	161 passes: *Myotis* spp.[(a)] , hoary, big brown and silver-haired bats	30 bats (0.24 /net-hr): little brown (25), hoary (3) and silver-haired (2) bats;	n/a	Gulf (2001)
2000	bat surveys of Central and Northwestern AB (Caribou River)	11.4 passes/hr[(b)] (total n/a): detected *Myotis* spp.[(a)] and larger spp.[(c)]	0 bats	dry mixedwood subregion	Vonhof and Hobson (2001)
2000	bat surveys of Central and Northwestern AB (Rainbow Lake)	15 passes/hr[(b)] (total n/a): detected *Myotis* spp.[(a)] and larger spp.[(c)]	2 bats over 4 nights: northern myotis	wet mixedwood subregion	Vonhof and Hobson (2001)
2000	bat surveys of Central and Northwestern AB (Sousa Creek)	39 passes/hr[(b)] (total n/a): *Myotis* spp.[(a)] and larger spp.[(c)]	11 bats over 6 nights: little brown (2), northern myotis (6) and big brown (3) bats	wet mixedwood subregion	Vonhof and Hobson (2001)
2000	bat surveys of Central and Northwestern AB (Wabasca River)	19.8 passes/hr[(b)] (total n/a): *Myotis* spp.[(a)] and larger spp.[(c)]	10 bats over 7 nights: little brown (7), northern myotis (2) and big brown (3) bats	central mixedwood subregion	Vonhof and Hobson (2001)
2001	bat surveys in Northeastern AB	approximately 270 passes (ca. 8.78 passes/hr): detected *Myotis* spp.[(a)], larger spp.[(c)] and hoary bats	36 bats (0.23 bat/net-hr): little brown (31), northern myotis (3) and silver-haired (2) bats	little brown bats captured primarily above water, northern long-eared bats captured in cutlines and silver-haired bats captured above water; no habitat for echolocation calls provided	Schowalter (2001) Hubbs and Schowalter (2003)
2001	Rio Alto Kirby Project	380 passes (15.3 passes/hr): *Myotis* spp.[(a)], larger spp.[(c)] and little brown bats	4 bats (0.06 bat/net-hr): little brown bats	captured in e2 cutline; detected primarily in FONG and BTNN	Rio Alto (2002)
2001	Petro-Canada Wildlife Surveys	45 passes (2.2 passes/hr): *Myotis* spp.[(a)] and large spp.[(c)]	1 bat (0.01 bat/net-hr): silver-haired	captured above water in MONG; detected primarily in d2 as well as in SONS, MONG and BTNN	Petro-Canada (2001)

Table E-34 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat	Reference
2001	Shell Jackpine Mine – Phase 1 Wildlife Surveys	101 passes (3.9 passes/hr): *Myotis* spp.[(a)], larger spp.[(c)] and little brown bats	6 bats (0.13 bat/net-hr): northern myotis (5) and little brown (1) bats	captured in b1, d1 and d2 cutlines; detected primarily in e2-cutline and SONS, as well as d1 forest, b1, d1 and d2 cutlines, FONS and STNN	Golder (2002a)
2001	Canadian Natural Horizon Project	323 passes (15.3 passes/hr); *Myotis* spp. [(a)], larger spp.[(c)], little brown and northern long-eared bats	4 bats (0.08 bat/net-hr): little brown (1), northern myotis (2) and silver-haired (1) bats	captured in a1-cutline and SONS; detected primarily in SONS, as well as in a1 and e1 forest and cutlines	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	28 passes and 2 feeding buzzes (1.75 passes/hr); *Myotis* spp.[(a)], larger spp.[(c)], little brown bats	7 captures (0.26 bat/net-hr): red (1), northern myotis (4), little brown (2) bats	captured in d2 and h1 ecosites along cutlines; red bat captured in h1 disturbance and first red bat captured in northern Alberta	Golder (2003c)
2004	MEG Christina Lake Regional Project	2.9 passes/hr, 0.5 buzzes per hour; *Myotis* spp.[(a)], big brown/silver haired, red and hoary bats	1 capture (0.04 bat/net-hr); little brown bat	captured in FTNN wetlands type along cutline; passes and feeding buzzes produced within c1, d2, FTNN and WONN	MEG (2005)
2004	Suncor Voyageur	n/a	3 captures; northern myotis (2), little brown (1) bats 5 captures; northern myotis (2), little brown (3) bats	captured in d2 in both LSAs	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	432 passes (3129 minutes) and 21 buzzes; *Myotis spp.* 3.2 passes/hr, red 1.4 passes/hr, hoary 1.0 passes/hr	2 little brown bats	captured in c1 and SONS; most activity in c1, d2, and d1	Canadian Natural (2006)
2005	Devon Jackfish 2 Project	n/a	2 little brown bats	captured along road	Devon (2006)
2006 to 2007	Suncor Voyageur South	13.7 passes/hr and 0.4 buzzes/hr (7 hours); big brown/silver-haired, high-frequency bat, hoary bat, little brown bat, little brown/red bat, little brown/northern long-eared bat, low-frequency bat, northern long-eared bat and silver-haired bat	1 red bat, 1 silver-haired bat, 8 northern myotis, 3 little brown bats	captured in d1-dist, d2-dist	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	15 passes (3.8 passes/hr), 0 buzzes; high frequency, big brown/silver-haired, little brown, and red bats detected	7 captures (0.20 bat/net-hr): 1 red bat, 2 silver-haired bats, 2 northern myotis, 2 little brown bats	captured in d2	EnCana (2009)

Table E-34 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat	Reference
2007	Shell Jackpine Mine Expansion and Pierre River Mine Projects	Jackpine - 570 passes, 27.2 passes/hour and 1.0 buzzes/hour; big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats detected Pierre River - 461 passes, 15.9 passes/hour and 0.4 buzzes/hour; big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats detected	Jackpine - 31 captures (0.64 bat/net-hr): two silver-haired bat, 24 northern myotis and five little brown bats Pierre River - 38 captures (0.26 bat/net-hr): 26 northern myotis and 12 little brown bats	majority of the bats captured in b1, d2, b2; most activity in BTNN, FTNN, WONN and d2	Shell (2007)
2007	StatoilHydro Kai Kos Dehseh	*Eptesicus fuscus/ Lasionycteris noctivigans 5 recordings* *Myotis lucifugus 12 recordings* *Lasiurus borealis 1 recording*	none	not recorded	North American (2007)
2007	Suncor Mine Dump 9 (MD9)	58 passes, 15.1 passes/hour and 1.0 feeding buzzes/hour; big brown/silver-haired, red bat, hoary/big brown/silver haired, little brown, northern long-eared and high-frequency bats detected	20 captures (0.83 bat/net-hr): one hoary bat, three silver-haired bats and 16 northern myotis	captured in d1, d2; most activity in d2, e2	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	15.2 passes/hour and 2.9 buzzes/hour (29.8) myotis bat species, big brown/silver-haired, red bat, and hoary bat	one little brown bat	captured in FTNN	MEG (2008)
2008	Total Joslyn Mine Expansion	high frequency bats 199.4 passes/hour, low frequency bats 1.0 passes/hour, and high frequency bats 16.7 buzzes/ hour (12 hours) myotis species or red bat and big brown bat or silver-haired were detected	three little brown bats, 18 northern myotis, one red bat, and one silver-haired bat,	captured in d1-dist, d2-dist, and d3-dist	Unpublished Data

Table E-34 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat	Reference
2008	Enerplus Kirby Project	21 passes and no feeding buzzes (7.4 passes/hr); big brown/silver-haired, northern long-eared, red, high and low frequency, northern long-eared/little brown, red/little brown and silver-haired bats detected	three little brown bats	captured in d1-dist, and burned b1 cutline; most activity in b1 (burn) and d1	Enerplus (2008)
2008	Cenovus Narrows Lake Project	57 passes and 22 feeding buzzes (13.2 passes/hr, and 5.1 feeding buzzes/hr); big brown/silver-haired, silver-haired, high and low frequency, little brown, northern long-eared/little brown bats detected	eight captures (0.1 bats per mist-net hour) four little brown four silver-haired	d1, d2, f2, h1 (all in disturbed cutline)	Cenovus (2010)
2008 to 2010	Dover Commercial Project	1,245 passes and 92 feeding buzzes (3.3 passes/hr and 0.2 feeding buzzes/hr); big brown/silver-haired, silver-haired, hoary, red, little brown, northern-long-eared, high and low frequency, northern long-eared/little brown bats detected	87 captures (0.23 bats per mist-net hour) 43 little brown bats, 19 northern myotis, and 25 silver-haired bats	captured along cutlines in b1, b2, b4, d1, d2, d3, e2; most activity in b3 and d2	Dover OPCO (2010)
2007, 2010 and 2011	CPC Surmont Project	9.6 passes/hr and 0.8 feeding buzzes/hr; hoary, little brown, red, silver-haired, big brown/silver-haired, little brown/northern myotis, and high and low frequency bats detected	21 captures (0.14 bats per mist-net hour) 12 little brown bats, 6 northern myotis, two hoary bats and 1 silver-haired bat	captured along cutlines in d1, d2, d3 and f1; highest activity in b1 and f3	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	8.3 passes/hr and 5.1 feeding buzzes/hr; big brown/silver-haired bats, high frequency bats, hoary bat, little brown bat, northern myotis and red bat detected	23 captures (0.30 bats/mist net hour) 22 little brown bats and 1 northern myotis	captured along cutlines in d1, d2, g1, and WONN	Cenovus (2011)

Table E-34 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat	Reference
2001, 2008, 2011 and 2012	Canadian Natural Kirby Expansion	539 passes and 131 feeding buzzes (13.0 passes/hr and 3.2 feeding buzzes/hr) little brown/northern myotis, little brown myotis, low frequency, big brown/silver-haired, high frequency, northern myotis, silver-haired and red bats detected	24 captures (0.133 bats per mist-net hour) 20 little brown myotis and 4 silver-haired bat	captured along cutlines in b1, c1, d1, d2, e2 and FTNN; highest activity in FONG	Present Study

(a) *Myotis* species are difficult to differentiate based on echolocation calls; therefore, they were sometimes grouped as *Myotis* spp.

(b) Numbers were extrapolated from figures and represent approximate mean values.

(c) Larger bat species could not be differentiated on basis of echolocation calls; therefore, they were grouped as larger spp. This group may include silver-haired and big brown bats.

n/a = Not applicable.

Table E-35 Small Mammal Survey Results Within the Region

Small Mammal Species	Year	Project	Abundance [# captures/100 trap nights unless otherwise noted]	Habitat	Reference
masked shrew	1979	Syncrude	abundant	n/a	Westworth (1979)
	1979	Syncrude	present	n/a	Michielsen and Radvanyi (1979)
	1997	Shell Muskeg River Mine Project	4 to 17	margins of moist fields, bogs, marshes and moist or dry woods, including mixedwood and upland coniferous	Golder (1997b)
	1980	AOSERP	common	aspen and willow habitats	Green (1980)
	1995	Alberta Environment Centre/Canadian Forest Service. Alberta Land and Forest Service	n/a	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	3	b2,d1,d3	Gulf (2001)
dusky shrew	1995	Alberta Environment Centre/Canadian Forest Service. Alberta Land and Forest Service	n/a	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	2	e3 and h1	Gulf (2001)
water shrew	1979	Syncrude	common	wet margins of lakes, streams, and muskegs	Westworth (1979)
arctic shrew	1979	Syncrude	scarce	n/a	Westworth (1979)
	1997	Shell Muskeg River Mine Project	n/a	bogs, marshes and grassy clearings	Golder (1997b)
	1995	Alberta Environment Centre/Canadian Forest Service, Alberta Land and Forest Service	n/a	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	1	FONS	Gulf (2001)
pygmy shrew	1979	Syncrude	common	n/a	Westworth (1979)
	1980	AEOSERP	common	aspen and willow habitats	Green (1980)
	1997	Shell Muskeg River Mine Project	uncommon	wooded areas (mixedwood), bogs, wet meadows and clearings within forests	Golder (1997b)
	2000	Gulf Surmont In-Situ Oil Sands Project	4	d1, FONS and FONG	Gulf (2001)

Table E-35 Small Mammal Survey Results Within the Region (continued)

Small Mammal Species	Year	Project	Abundance [# captures/100 trap nights unless otherwise noted]	Habitat	Reference
least chipmunk	1997	Shell Muskeg River Mine Project	n/a	clearings, forest edges and disturbed areas	Golder (1997b)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)
	2004 to 2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
red-backed vole	1979	Syncrude	9.3 to 19.1	n/a	Westworth (1979)
	1980	AOSERP[(a)]	abundant	forest and shrub-dominant habitats, balsam poplar, aspen and jack pine communities	Green (1980)
	1984	Syncrude Mildred Lake	n/a	prefer balsam poplar, mixedwood and tamarack forest	Syncrude (1984)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)
	1997	Shell Muskeg River Mine Project	n/a	disturbed areas, mixedwood, riparian, upland coniferous forests and wetlands	Golder (1997b)
heather vole	2000	OPTI Long Lake Project	n/a	deciduous, upland coniferous, mixedwood forests, riparian areas and wetlands	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	38	b2,b3,d1,d2,d3, e1, e3, h1, BTNN, FONS and FONG	Gulf (2001)
	2002	Suncor South Tailings Pond Project	1	e2	Golder (2003b)
	2004	Suncor Monitoring Five Year Report	1.3/trap night	n/a	Golder (2004b)
	2004	Suncor Voyageur	no observations 5 captured total	n/a observed in b1, b3, d2, FTNN	Golder (2005)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)
	1979	Syncrude	common-abundant	n/a	Westworth (1979)
	1979	AOSERP	n/a	forest and shrub-dominant habitats. Moist habitats with dense grass or sedge cover	Green (1979)
	1984	Syncrude Mildred Lake	n/a	prefers successional areas, willow shrub and tamarack forests	Syncrude (1984)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)

Table E-35 Small Mammal Survey Results Within the Region (continued)

Small Mammal Species	Year	Project	Abundance [# captures/100 trap nights unless otherwise noted]	Habitat	Reference
meadow vole	1997	Shell Muskeg River Mine Project	n/a	clearings, wet meadows with grass cover, disturbed areas, mixedwood, riparian, upland conifer forest and wetlands	Golder (1997b)
	2000	OPTI Long Lake Project	n/a	riparian	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	5	b2,d1, h1 and FONS	Gulf (2001)
	2002	Suncor South Tailings Pond Project	7	shrubby grassland	Golder (2003b)
	2004	Suncor Monitoring Five Year Report	2.5/trap night	n/a	Golder (2004b)
deer mouse	1979	Syncrude	abundant	n/a	Westworth (1979)
	1979	Syncrude	abundant	n/a	Michielsen and Radvanyi (1979)
	1979	AOSERP	n/a	grasslands and early successional habitats	Green (1979)
	1980	AEOSERP	n/a	forest and shrub-dominant habitats and recently disturbed areas (e.g. cutblocks)	Green (1980)
	1984	Syncrude Mildred Lake	n/a	most abundant in aspen, balsam poplar or mixedwood forests	Syncrude (1984)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)
	2000	OPTI Long Lake Project	n/a	deciduous, coniferous and mixedwood forests and riparian	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	16	a1,b2, b3, d1 and d2	Gulf (2001)
	1993	University of Alberta	n/a	aspen mixedwood	Moses and Boutin (2001)
	2002	Suncor South Tailings Pond Project	38	e1, e2, deciduous-willow, deciduous misc., mixedwood grassland, mixedwood willow, shrubby grassland	Golder (2003b)
	2004	Suncor Monitoring Five Year Report	30/trap night	n/a	Golder (2004b)
meadow jumping mouse	1997	Shell Muskeg River Mine Project	n/a	grasslands, riparian meadows, clearings, forest edges	Golder (1997b)
	2000	OPTI Long Lake Project	n/a	riparian	OPTI (2000)
northern bog lemming	1997	Shell Muskeg River Mine Project	n/a	wet forested areas, bogs, riparian and wetlands	Golder (1997b)
	2000	OPTI Long Lake Project	n/a	wetlands	OPTI (2000)

Table E-35 Small Mammal Survey Results Within the Region (continued)

Small Mammal Species	Year	Project	Abundance [# captures/100 trap nights unless otherwise noted]	Habitat	Reference
flying squirrel	2004 to 2005	Canadian Natural Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
mice and voles combined	2005	Devon Jackfish 2 Project	n/a	observed in d3, i1, j2, c1, and b1	Devon (2006)
mice and voles combined	2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.27 tracks/km-day	highest densities on cutlines, SONS and c1	Cenovus (2011)

[(a)] AOSERP = Alberta Oil Sands Environmental Research Program.

n/a = Not applicable.

Table E-36 Owl Survey Results Within the Region

Year	Project	Species [Abundance]	Habitat	Reference
1997	Shell Muskeg River Mine	boreal owl (7)	mixedwood, trembling aspen	Golder (1997a)
		great horned owl (1)	black spruce stand	
		Incidentals: great gray owl (4)	unknown	
1998	Steepbank River Valley, Shipyard Lake, and Lease 25 and 29 Uplands	great gray owl (1)	STNN	Golder (1998b)
		Incidentals: great gray owl (1)	a1	
		northern hawk owl (1)	BTNN	
1998	Suncor Project Millennium	great gray owl (1)	STNN	Golder (1998a)
		Incidentals: great gray owl (2)	riparian area, a1	
2000	Firebag Project	great horned owl (7)	FONS, FTNN, d2, g1, h1	Golder (2000e)
		great gray owl (1)	FONS	
		boreal owl (5)	FTNN, g1	
		barred owl (4)	FTNN, d2, g1	
		Incidentals (1998): great gray owl great horned owl northern hawk owlk unknown owl	e1 f2, BTNN FTNN, c1 FTNN, BTNN, e1	
2000	Canadian Natural PAW Project	great-horned owl (10)	shrubby fen, poplar/aspen, aspen/white spruce, white spruce, poor fen/bog, treed fen	Canadian Natural (2000)
		northern-hawk owl (2)	aspen/white spruce, poplar/aspen	
		boreal owls (3)	aspen/white spruce, white spruce/jack pine	
		short-eared owl (1)	shrubby fen	
		northern saw-whet owl (1)	poplar/aspen	
		barred owl (1)	white spruce	
2000	OPTI Long Lake Project	great horned owl (16)	b3, d1, d2, g1, BTNN, SONS	OPTI (2000)
		great gray owl (4)	b2, b3, BTNN	
		boreal owl (10)	g1, BTNN	
		barred owl (15)	b2, b3, d1, d2	

Table E-36 Owl Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2000	Gulf-Surmont In-Situ Oil Sands Project	barred owl (14)	b1, b2, d1, d2, h1, i1, j1	Gulf (2001)
		boreal owl (1)	i1	
		great horned owl (25)	b1, b2, d1, d2, e1, i1, j1	
		long-eared owl (1)	k3	
		Incidentals: barred owl (27)	a1, b1, b2, c1, d1, e1, h1, i1, j1	
		boreal owl (6)	d2, i1, j1, k1	
		great gray owl (7)	d1, e1, i1, k2, k3	
		great horned owl (34)	b1, b2, d1, d2, e1, i1, j1	
		long-eared owl (2)	f1, k3	
		northern saw-whet owl (2)	c1, d1	
2001	Albian Sands Muskeg River Mine Project Wildlife Assessment	great horned owl (1)	b4	Westworth (2001)
		Incidentals: great horned owl (5)	shrubland, d1, unknown	
		great gray owl (1)	j2	
2001	PanCanadian Christina Lake Thermal Project Wildlife Monitoring	great horned owl (5)	f3, FTNN	Golder (2000b)
		boreal owl (3)	e3, c1/g1, FTNN	
2001	Rio Alto Kirby Project	great horned owl (10)	b1, d2, g1, FTNN	Rio Alto (2002)
		boreal owl (2)	b1, d2	
2001	Petro-Canada Meadow Creek Project	great horned owl (4)	b1, g1, SONS	Petro-Canada (2001)
		great gray owl (1)	d2	
		boreal owl (2)	SONS, FONG	
		barred owl (5)	b3, c1, d2, g1, FTNN	
2001	Shell Jackpine Mine – Phase 1	great horned owl (5)	d2, BTNN, FTNN	Golder (2002a)
		great gray owl (1)	BTNN	
2001	Canadian Natural Horizon Project	great horned owl (24)	d2, d3, BTNN, FTNN, cutblock	Canadian Natural (2002)
		boreal owl (14)	a1, d2, BTNN, FTNN	
		barred owl (8)	b1, d2, e3	
2002	Suncor South Tailings Pond Project	boreal owl (11)	d1, d2, h1, FONS, FTNN, STNN	Golder (2003c)
		barred owl (2)	d3, SONS	
		great gray owl (1)	BTNN	
		great horned owl (1)	b3	
		northern saw-whet owl	STNN	

Table E-36 Owl Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2002	Devon Jackfish Project	boreal owl (19)	unknown	Devon (2003)
		northern saw-whet owl (4)		
		great horned owl (4)		
		barred owl (1)		
		Incidentals: great gray owl (1)		
2003	Cenovus Christina Lake Thermal Project	boreal owl (4)	BTNN,b2 and g1 BTNN,FTNN,d2,e2 and g1	Golder (2004a)
		northern saw-whet owl (8)		
		Incidentals: boreal owl (3) great gray owl (2) great-horned owl (3) northern saw-whet owl (4)		
2004	MEG Christina Lake Regional Project	boreal owl (9) barred owl (5) great gray owl (8) great horned owl (3)	c1, burn, b1, d1, FTNN, FONS, disturbed a1, burn, BTNN, d1, STNN BTNN, FONS, a1, c1, burn c1, d2, burn	MEG (2005)
2004	Suncor Monitoring Five Year Report	boreal owl (13)	aspen-white spruce; black spruce; white spruce -aspen; black spruce-birch and black spruce-aspen	Golder (2004b)
		great gray owl (3)	black spruce and black spruce- tamarack	
		barred owl (1)	cutblock area – aspen-white spruce	
2004	Suncor Voyageur	boreal owl (4)	aspen-white spruce	Golder (2005)
		great horned owl (1)	d1	
2004 to 2005	Canadian Natural Primrose East Expansion	boreal owl (14)	a1, b1, FTNN, FONS/BTNN, MONG, h1	Canadian Natural (2006)
		great gray owl (4)	a1, FONG, FONS/BTNN	
		northern saw-whet owl (1)	h1	
2005	Devon Jackfish 2 Project	*Incidentals:* barred owl (2) great gray owl (3) short-eared owl (1)	unknown	Devon (2006)

Table E-36 Owl Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2006	Suncor Voyageur South	boreal owl (18)	d1, d2, BTNN, FTNN, SONS, STNN, disturbed (industrial), cutblock	Suncor (2007)
		great gray owl (4)	d1, d2, FTNN, cutblock	
		barred owl (1)	d3	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	boreal owl (75)	a1, b1, BTNN, d1, e1, FONS, FOPN, FTNN, g1, h1, MONG, road, STNN	EnCana (2009)
		barred owl (5)	BTNN, FTNN, g1	
		great gray owl (18)	a1, BTNN, c1, FONS, FTNN, STNN	
		great horned owl (28)	a1, BTNN, c1, d1, FONS, FOPN, FTNN, g1, h1, MONG, SONS, STNN	
		long-eared owl (3)	a1, b1, MONG	
		northern saw-whet (4)	h1, FTNN	
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	(Jackpine, Pierre River): boreal owl (29, 31)	a1, b2, b3, BTNN, c1, d1, d3, e2, FONS, FTNN, g1, SONS, disturbed	Shell (2007)
		barred owl (0, 14)	a1, d2, d3	
		great gray owl (2, 9)	a1, d2, e2, FTNN, g1, disturbed	
		great horned owl (8, 6)	a1, BTNN, d2, FTNN	
		long-eared owl (0, 2)	a1, FTNN	
		northern saw-whet (2, 2)	a1, disturbed	
2007	StatoilHydro Kai Kos Dehseh	barred owl (5) boreal owl (1) great gray owl (1) great horned owl (2) northern pygmy owl (3)	c1, d1 c1 clearcut b2 clearcut, d1, g1	North American (2007)
2007	Suncor Mine Dump 9 (MD9)	boreal owl (27)	d1, d2, d3, e3, BTNN, FTNN, disturbed	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	barred owl (5) boreal owl (9) great gray owl (8) great horned owl (3)	a1, d1, BTNN, STNN, burn b1, c1, d1, FTNN, FONS, burn, disturbed a1, c1, BTNN, FONS, burn c1, d2, burn	MEG (2008)
2008	Total Joslyn Mine Expansion	barred owl (4) boreal owl (24) great gray owl (2) great horned owl (30) northern saw-whet owl (2) boreal owl (3)	b1, d1, a1, d1, d2, d3, BONS, FTNN d1 d1, f2, BONS, BTNN, FONG, FONS, FTNN FTNN a1, d1, d2, d3, BONS, FTNN	Unpublished Data
2008	Enerplus Kirby Project	boreal owl (3)	burned a1, burned g1, BTNN	Enerplus (2008)

Table E-36 Owl Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2008	Cenovus Narrows Lake Project	barred owl (2) boreal owl (15) great gray owl (1) great horned owl (1) northern saw-whet owl (1)	d2 a1, g1, BTNN, FONS, FTNN FONS FONS FONS	Cenovus (2010)
2008 to 2009	MacKay River Commercial Project	*Incidentals:* great horned owl (1) barred owl (2)	 deciduous coniferous, deciduous	AOSC (2009)
2008	West Ells SAGD Project	great horned owl (2) boreal owl (5) barred owl (1)	unknown	Sunshine (2010)
2008 to 2010	Dover Commercial Project	boreal owl (21) barred owl (4) great gray owl (3) great horned owl (8)	primarily BTNN and c1 d1, d2 unknown c1, d2, g1, FONS, FTNN	Dover OPCO (2010)
2007, 2010 and 2011	CPC Surmont Project	boreal owl (29) northern saw-whet owl (4) barred owl (4) great grey owl (3) great horned owl (20)	most in d2, BTNN and FONS d1, d2, f2, burned upland d1, d2 and SONS d2, FTNN and MONG most in d1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	barred owl (1) boreal owl (11) great grey owl (1) great horned owl (6) long-eared owl (1) northern saw-whet owl (1)	e2 BTNN, FONS, FTNN, d1, d2, e1, e2, g1 FONS c1, g1, BTNN, FTNN g1 b3	Cenovus (2011)
2001, 2008, 2011 and 2012	Canadian Natural Kirby Expansion	boreal owl (22) great gray owl (3) great horned owl (16)	FFNN, MONG, FTNI FTNI and disturbed FFNN, FTNI, d1	Present Study

Table E-37 Raptor Survey Results Within the Region

Year	Project	Species [Abundance]	Habitat	Reference
1996	Suncor Steepbank Mine	broad-winged hawk (1)	riparian deciduous forest	Westworth, Brusnyk and Associates (1996b)
		northern goshawk (1)	over Athabasca River	
		northern harrier (1)	near Athabasca River	
		bald eagle (1)	east bank of Athabasca River	
		bald eagle nest (1)	aspen grove	
		unidentified accipiter (1)	near Beaver River	
		Incidentals: red-tailed hawk (1) northern harrier (1) sharp-shinned hawk (2) American kestrel (1) bald eagle (3) sharp-shinned hawk (2) broad-winged hawk (1) northern harrier (1)	open Sb-Labrador tea closed shrub complex habitat adjacent to aspen cutblock adjacent to aspen cutblock near Athabasca River east of wetlands east side of Ruth Lake north end of reservoir	
1997	Shell Muskeg River Mine	*Incidentals:* red-tailed hawk (n/a)	unknown	Golder (1997b)
1998	Suncor Project Millennium	bald eagle (1)	unknown	Golder (1998a)
		red-tailed hawk (1)	lake area	
		Incidentals: red-tailed hawk (n/a)	unknown	
1998	Mobil Lease 36	*Incidentals:* bald eagle (2)	unknown	Golder (1999b)
2000	Firebag Project	*Incidentals (1998):* northern harrier (n/a) rough-legged hawk (n/a) *Incidentals (1999):* northern harrier (2)	FONS BTNN BTNN; FONS	Golder (2000e)
2000	Canadian Natural PAW Project	*Incidentals*: goshawks red-tailed hawk northern harrier ospreys	marsh, treed fens jack pine/aspen, shrubby swamp shrubby swamp, deep water near a pond	Canadian Natural (2000)

Table E-37 Raptor Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2000	OPTI Long Lake Project	*Incidentals:* broad-winged hawk (2) Cooper's hawk (1) northern goshawk (9) northern harrier (6) osprey (2) red-tailed hawk (2) sharp-shinned hawk (1)	 mixedwood mixedwood mixedwood, ponds, Gregoire River, Sb bog, willow, deciduous fen, mixedwood, ponds Canoe Lake, Kiskatinaw Lake Gregoire River, fen Dogwood (e1)	OPTI (2000)
2000	Gulf-Surmont In-Situ Oil Sands Project	northern goshawk (10) *Incidentals:* Cooper's hawk (1) sharp-shinned hawk (2)	d2, e2, h1, e1, d1 d1 d1, k2	Gulf (2001)
2001	Albian Sands Muskeg River Mine Project Wildlife Assessment	northern harrier (3) sharp-shinned hawk (9) northern goshawk (3) broad-winged hawk (11) red-tailed hawk (15) American kestrel (9) merlin (5)	j2 e2, d1, Lt-Sb d1 d1, d2, f1 b4, d1, b1 k2 b3	Westworth (2001)
2001	PanCanadian Christina Lake Thermal Project Wildlife Monitoring	broad-winged hawk (1) unknown raptor (1)	FTNN f3	Golder (2000b)
2001	Firebag Project Supplemental	northern harrier (3)	b3, j1, b4	Golder (2000e)
2001	Rio Alto Kirby Project	red-tailed hawk (3) northern harrier (1) sharp-shinned hawk (1) Swainson's hawk (2) unknown raptor (1)	b1, FTNN FTNN FTNN c1 d1	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	northern goshawk (2) northern harrier (1) unknown raptor (3)	g1, BTNN c1 BTNN, FTNN	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	northern goshawk (1) American kestrel (1)	STNN FONS	Golder (2002a)

Table E-37 Raptor Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2001	Canadian Natural Horizon Project	bald eagle (2) osprey (2)	MONG MONG	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	American kestrel (1) broad-winged hawk (1) northern harrier (1)	clearcut clearcut STNN	Golder (2003c)
2002	Suncor South Tailings Pond Project	American kestrel (1) broad-winged hawk (1) northern harrier (1)	clearcut clearcut STNN	Golder (2003b)
2003	Cenovus Christina Lake Thermal Project	Cooper's hawk (1) *Incidentals:* northern harrier(1) red-tailed hawk(1) sharp-shinned hawk(1)	d2	Golder (2004a)
2004	MEG Christina Lake Regional Project	sharp-shinned hawk (1) northern goshawk (1) merlin (1) *Incidentals:* bald eagle (5) northern harrier (2) osprey (2) American kestrel (1)	BTNN d2 FTNN	MEG (2005)
2004	Suncor Voyageur	American kestrel (1) sharp-shinned hawk (2) unknown raptor (1)	FTNN d2, BTNN FTNN	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	northern goshawk (1) *Incidentals:* sharp-shinned hawk (2) northern harrier (1) unknown raptor (1)	d2 FTNN FONS unknown	Canadian Natural (2006)

Table E-37 Raptor Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2005	Devon Jackfish 2 Project	Cooper's hawk (2)	unknown	Devon (2006)
		northern goshawk (2)		
		sharp-shinned hawks (2)		
		red-tailed hawk (2)		
		northern harrier (7)		
		broad-winged hawk (1)		
		peregrine falcon (1)		
		Incidentals: northern goshawk (2) broad-winged hawk (2)		
2008 to 2009	MacKay River Commercial Project	northern harrier (8) northern goshawk (7) broad-winged hawk (2) red-tailed hawk (4) American kestrel (3) merlin (1)	bog, fen, coniferous coniferous deciduous, mixed-wood deciduous bog, fen coniferous coniferous, deciduous fen	AOSC (2009)
2008	West Ells SAGD Project	red-tailed hawk (1) sharp shinned hawk (1)	unknown	Sunshine (2010)
2008 to 2010	Dover Commercial Project	*Incidentals:* unknown raptor (5)	b3, c1, d2	Dover OPCO (2010)
2007, 2010 and 2011	CPC Surmont Project	*Incidentals*: bald eagle (1) northern goshawk (3) red-tailed hawk (1) rough-legged hawk (2) osprey (1) unknown raptor species (3)	 d2 d1, d2, h1 d1 d1, d2 d2 d2, BTNN	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	*Incidentals:* American kestrel (3) bald eagle (2) golden eagle (1) merlin (4) northern harrier (4) red-tailed hawk (1) rough-legged hawk (5)	 d1, d2 unknown unknown FONS BTNN, FONG, disturbed d1 FTNN	Cenovus (2011)

Table E-37 Raptor Survey Results Within the Region (continued)

Year	Project	Species [Abundance]	Habitat	Reference
2001, 2008, 2009 and 2011	Canadian Natural Kirby Expansion	*Incidentals:* American kestrel (1) northern goshawk (2) northern harrier (12) red-tailed hawk (1) rough-legged hawk (2) Swainson's hawk (2) osprey (1) merlin (1) unknown raptor (3)	 BTNN c1, FONS c1, d1, FONG, FONS, FTNN, lake, SONS FTNN FONG, FTNN STNN burn b3 FTNN, BTNN	Canadian Natural (2011)
2010 to 2011	Canadian Natural Bich Mountain East	*Incidentals:* American kestrel (1) broad-winged hawk (5) northern harrier (2)	 MONG STNN d2	Unpublished Data

Table E-38 Grouse Survey Results Within the Region

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
1995	Solv-Ex	3.04	most in aspen and aspen-white spruce[(a)]	Bovar-Concord Environmental (1995)
1997	Shell Muskeg River Mine	1.71	preferred wetlands shrub complex; avoided closed mixedwood, closed mixed coniferous and riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.36 January 0.99 in February	January: preferred FTNN; avoided d1, d3, h1, BTNN, shrub and WONN February: preferred FTNN; avoided a1, d3, d2, d1 and BTNN	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.19 in January 0.30 in February 0.05 in March	did not show a landscape preference	Golder (1998a,b)
1997	Mobil Lease 36	0.36	most in white spruce-aspen and aspen-white spruce mixedwood forests[(a)]	URSUS and Komex (1997)
1998	Suncor Firebag Project	10.60	preferred FONS and FTNN/FFNN; avoided a1, b1, b2, b4, c1, d1, d2, d3 and g1	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	1.76 in reclaimed 2.06 in riparian area beside disturbance	not determined	Golder (1999a)
2000	ATCO Pipeline	mean: 3.1	most common in d3, also common in FTNN	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.07	preferred STNN and SONS; avoided a1, b1, d1, d2, d3, e1, e2, g1, Shrub and BTNN	Golder (2000a)
2000	Suncor Wildlife Monitoring	4.55 in Lease 86/17 0.63 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.14	most tracks observed in the d2 and h1	OPTI (2000)
2001	Rio Alto Kirby Project	0.17	tracks observed in d2 and FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.34	most tracks observed in the d2 and b1	Petro-Canada (2001)
2001	Canadian Natural Horizon Project	0.33 (upland game birds)	observed mostly in d2, followed by d1, b3, d3, e3, STNN and burn	Canadian Natural (2002)
2001	Jackpine Mine – Phase 1	0.19 (upland game birds)	observed in b3, d2, d3	Golder (2002a)
2002	Suncor South Tailings Pond	0.38 (upland game birds)	observed in d2, FONS, cutblock	Golder (2003c)
2003	Cenovus-Christina Lake Thermal Project	1 ruffed grouse and 4 spruce groused observed incidentally	unknown	Golder (2004a)
2004	MEG Christina Lake Regional Project	0.60	observed in a1, b2, d1, d2, g1, FONS, FTNN	MEG (2005)
2004	Suncor Voyageur	0.46 0.14	preferences not established no habitat preference	Golder (2005)

Table E-38 Grouse Survey Results Within the Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat	Reference
2004 to 2005	Canadian Natural Primrose East Expansion	0.46	preference for c1, avoidance of WONN	Canadian Natural (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	0.2	most observed in f2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.83	primarily observed in d2, h1, FONS	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.39	primarily observed in FTNN, g1	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	Jackpine - 0.76 Pierre River - 1.68	primarily observed in a1, b3, d2, d3 primarily observed in d1, SONS	Shell (2007)
2008	MEG Christina Lake Regional Project Phase 3	0.50	primarily observed in a1, b1, b3, FONS and reclaimed	MEG (2008)
2008	Total Joslyn Mine Expansion	0.58	primarily observed in b1, b4, d1, and f1	Unpublished Data
2008	Enerplus Kirby Project	1.44	primarily observed in BONS	Enerplus (2008)
2007 to 2008	MacKay River Commercial Project	0.41	primarily observed in e3, j2, and b3	AOSC (2009)
2008	West Ells SAGD Project	1	primarily in deciduous dominated mixedwood	Sunshine (2010)
2008 to 2009	McKay SAGD Pilot Project	0.00-5.43 (depending on habitat)	primarily in h1	Southern Pacific (2009)
2009 to 2010	Cenovus Narrows Lake Project	0.72	primarily observed in a1 and d2, secondarily observed in b1, b3, c1, d1, d3, g1, BTNN, FONS, FTNN, STNN and disturbed-linear	Cenovus (2010)
2008 to 2010	Dover Commercial Project	0.42	most tracks observed in BTNN, a1, FONS; highest density in a1	Dover OPCO (2010)
2011	CPC Surmont Project	0.15	highest track density observed in STNN and g1	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	0.48	highest track density observed in b1 and g1	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansioon	0.46	highest track density observed in h1, a1 and b1	Present Study

[a] Not statistically significant.

Table E-39 Marsh Bird Survey Results Within the Region

Year	Project	Species	Habitat	Reference
2002	Suncor South Tailings Pond Project	no incidental observations	n/a	Golder (2003b)
2003	Cenovus – Christina Lake Thermal Project	no incidental observations	n/a	Golder (2004a)
2004	MEG Christina Lake Regional Project	American bittern (1) visual incidental	lake shore	MEG (2005)
		sora (1) audio incidental	WONN	
2004	Suncor Voyageur	(North Steepbank – 1 sora incidental) (North Steepbank – 1 American bittern incidental)	unknown	Golder (2005)
2006	Suncor Voyageur South	American bittern (1) + 2 incidentals	disturbed cutline/ ditch (1) 2 audio incidentals = d2 and lake/pond	Suncor (2007)
		sora (26) + 4 incidentals	Lakes/ponds (16), near creek (4), cutlines/ditches (6) [Alternate breakdown = Disturbed (12), SONS (5), WONN (3), MONG (2), d1, FONG, FONS, FTNN each had 1 observation] 4 audio incidentals = ditch, standing water, lake/pond	
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	American bittern (1)	FTNN (standing water)	EnCana (2009)
		sora (10) + 1 incidental	SONS (3), MONG (2), FTNN (2), d3, e2 and STNN each had 1 occurrence.	
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	American bittern (6 – Pierre River)	SONS (2), FONG, FTNN, MONG, f2 (all 1 each)	Shell (2007)
		pied-billed grebe (2 – Pierre River)	MONG (2)	
		sora (20 – Pierre River and 16 – Jackpine)	Pierre River = MONG (7), SONS (5), FTNN (2), h1 (2), b2, FONG, STNN and cutline all had 1 occurrence. Jackpine = unknown (5), MONG (4), FONG (2), FTNN (2), d1, SONS and WONN all had 1 occurrence.	
2007	Suncor Mine Dump 9 (MD9)	no observations	n/a	Suncor (2008)
2008	Total Joslyn Mine Expansion	American bittern (1)	WONN	Unpublished Data
		sora (12)	MONG (9), SONS (1), WONN (2)	
2008	Enerplus Kirby Project	pied-billed grebe (1)	FONG (standing water)	Enerplus (2008)
		sora (3)	2 in STNN (standing water), 1 in MONG (lake margin)	
2008	Cenovus Narrows Lake Project	American bittern (1)	SONS near creek	Cenovus (2010)
		sora (4)	FTNN (2) near lake, SONS (2) near creek, BTNN (1) near lake	

Table E-39 Marsh Bird Survey Results Within the Region (continued)

Year	Project	Species	Habitat	Reference
2008 to 2009	MacKay River Commercial Project	American bittern (26) sora (115) yellow rail (11) pied-billed grebe (8)	habitats not reported; observations were apparently incidental.	AOSC (2009)
2008	West Ells SAGD Project	sora	unknown	Sunshine (2010)
2009	McKay SAGD Pilot Project	sora	shrub	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	sora (1) *Incidentals:* American bittern (3)	FONS	Dover OPCO (2010)
2007, 2010 and 2011	CPC Surmont Project	sora (53) pied-billed grebe (4) American bittern (1)	most in MONG BTNN, WONN, MONG, FONS FONS	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	no observations	n/a	Cenovus (2011)
2008, 2011 and 2012	Canadian Natural Kirby Expansion	sora (18)	WONN, FONG, FONS, lake and disturbed	Present Study

n/a = Not applicable.

Table E-40 Yellow Rail Survey Results Within the Region

Year	Project	Results [total number observed]	Habitat	Reference
2008	Imperial Oil Kearl Oil Sands Project Regulatory Follow-up	31	FONG (5); FONS (26)	Imperial Oil (2008)
2008	Suncor Firebag 2008 Wildlife Monitoring Program	no observations	n/a	Golder (2009a)
2008	Shell Jackpine Mine Expansion and Pierre River Mine Project EIA Follow-Up	4	FONG (3); FONS (1)	Golder (2009b)
2009	Suncor Firebag 2009 Wildlife Monitoring Program	no observations	n/a	Golder (2010)
2010 and 2011	Cenovus Pelican Lake Grand Rapids Project	no observations	n/a	Cenovus (2011)
2010	Shell Muskeg River Mine Expansion Project Wildlife Monitoring Program	19	FONG (19)	Unpublished data
2010	Dover Commercial Project	1	FONS (1)	Dover OPCO (2010)
2010 and 2011	CPC Surmont Project	9	FONG (3); FONS (6)	Unpublished Data
2011 and 2012	Canadian Natural Kirby Expansion	no observations	n/a	Present Study

n/a = Not applicable.

Table E-41 Horned Grebe Survey Results Within the Region

Year	Project	Results [total number observed]	Habitat [total number observed; mean relative abundance ± SD]	Reference
2011	CPC Surmont Project	2	WONN (2; 0.1±0.5)	Unpublished Data
2011 and 2012	Canadian Natural Kirby Expansion	2	Lake (2; 0.1±0.5)	Present Study

n/a = Not applicable.

Table E-42 Breeding Bird Survey Results Within the Region

Year	Project	Richness [Range][(a)]	Diversity [Range][(a)]	Listed Species [Observed Only]	Reference
1997	Shell Muskeg River Mine	6.30 to 16.0[(b)]	1.50 to 2.50	blackburnian warbler Cape May warbler	Golder (1997b)
1998	Suncor Project Millennium	2.17 to 4.40	0.67 to 1.36	bay-breasted warbler blackburnian warbler black-throated green warbler Canada warbler Cape May warbler western tanager	Suncor (1998)
1998	Firebag Project	9.1 to 9.3	1.5 to 1.8	blackburnian, Canada and Cape May warblers	Suncor (2000)
2000	OPTI Long Lake Project	1.56 to 3.13	0.35 to 0.97	bay-breasted warbler Cape May warbler western tanager	OPTI (2000)
2000	Canadian Natural PAW Project	1.60 to 2.80	0.30 to 0.90	bay-breasted warbler Cape May warbler	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	n/a	n/a	Cape May warbler bay-breasted warbler	TrueNorth (2001)
1998	Gulf Surmont In-situ Oil Sands Project	47 total richness	1.00 to 17.0	bay-breasted, black-throated green, Canada and Cape May warblers western tanager	Gulf (2001)
2001	Firebag Project Supplemental	1.00 to 4.50	0.90 to 3.05	none observed	Golder (2000e)
2001	Canadian Natural PAW Project Supplemental	2.70 to 4.60	1.30 to 3.30	bay-breasted, black-throated green, Canada and Cape May warblers	Canadian Natural (2000)
2001	Rio Alto Kirby Project	1.00 to 5.00	0.00 to 3.60	western tanager	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	1.00 to 4.00	0.00 to 2.51	Cape May warbler western tanager	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1 Project	1.00 to 7.00	0.00 to 6.15	bay-breasted Canada and Cape May warblers western tanager	Golder (2002a)
2001	Canadian Natural Horizon Project	2.17 to 6.33	0.75 to 5.12	bay-breasted black-throated green Canada and Cape May warblers black-backed woodpecker pileated woodpecker western tanager	Canadian Natural (2002)

Table E-42 Breeding Bird Survey Results Within the Region (continued)

Year	Project	Richness [Range][(a)]	Diversity [Range][(a)]	Listed Species [Observed Only]	Reference
2002	Suncor 86/17 Wildlife Monitoring	6.33 to 7.57	5.72 to 7.42	black-throated green warbler horned grebe great blue heron sandhill crane western tanager	Golder (2003b)
2002	Suncor South Tailings Pond	2.14 to 2.72	0.89 to 1.41	bay-breasted warbler pileated woodpecker Cape May warbler western tanager	Golder (2003c)
2002	Devon Jackfish Project	48 total richness	1.00 to 3.80	black tern pileated woodpecker Cape May warbler black-throated green warbler bay-breasted warbler Canada warbler western tanager	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	39 total richness	2.8 to 5.5 mean diversities)	pileated wood-pecker short-billed dowitcher Cape May warbler	Golder (2004a)
2004	MEG Christina Lake Regional Project	1.84 to 1.88 (mean richness)	0.65 to 0.93 (mean diversities)	none observed	MEG (2005)
2004	Suncor Monitoring Five Year Report	5.42 to 6.58 (2002) 4.14 to 5.08 (2003)	4.13 to 5.55 (2002) 2.89 to 3.95 (2003)	horned grebe great blue heron sandhill crane common nighthawk pileated woodpecker Canada warbler western tanager	Golder (2004b)
2004	Suncor Voyageur	1.31 to 2.05 1.65 to 2.83	2.38 to 3.12 3.07 to 4.25	western tanager pileated woodpecker Canada warbler Cape May warbler blackburnian warbler bay-breasted warbler	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	0.5 to 3.00	0.25 to 1.43	pileated woodpecker	Canadian Natural (2006)

Table E-42 Breeding Bird Survey Results Within the Region (continued)

Year	Project	Richness [Range][(a)]	Diversity [Range][(a)]	Listed Species [Observed Only]	Reference
2005	Devon Jackfish 2 Project	64 total richness	2.6 to 4.3	pileated woodpecker black-backed woodpecker bay-breasted warbler Cape May warbler western tanager	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	71 total richness	4.8 to 18.4	black tern pileated woodpecker Cape May warbler bay-breasted warbler Canada warbler western tanager	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1.5 to 8.0	0.3 to 7.3	Canada warbler bay-breasted warbler Cape May warbler common yellowthroat western tanager eastern phoebe	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	0.5 to 8.0	0.0 to 7.7	bay-breasted warbler brown creeper common yellowthroat least flycatcher northern hawk-owl	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	1.3 to 5.8	0.3 to 4.7	bay-breasted, Canada, and Cape May warblers black-backed woodpecker black tern brown creeper common yellowthroat great gray owl least and yellow-bellied flycatchers rusty blackbird western tanager	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	1.0 to 5.0	0.15 to 4.03	bay-breasted and Cape May warblers	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	1.0 to 2.35	0.23 to 1.16	brown creeper and least flycatcher	MEG (2008)

Table E-42 Breeding Bird Survey Results Within the Region (continued)

Year	Project	Richness [Range][(a)]	Diversity [Range][(a)]	Listed Species [Observed Only]	Reference
2008	Total Joslyn Mine Expansion	84.9 to 489.2 territories/40 ha	2.0 to 15.8	bay-breasted, black-throated green, Canada, and Cape May warblers common yellowthroat least flycatcher western tanager	Unpublished Data
2008	Enerplus Kirby Project	1.0 to 4.0	0.30 to 2.09	common yellowthroat common nighthawk	Enerplus (2008)
2008 to 2009	Cenovus Narrows Lake Project	0 to 2.8	0 to 1.4	least flycatcher (1) Canada warbler (1) bay-breasted warbler (1) common yellowthroat (1)	Cenovus (2010)
2008	MacKay River Commercial Project	54 species detected	insufficient information on index used	olive-sided flycatcher (10) least flycatcher (19) brown creeper (4) Cape May warbler (19) common yellowthroat (44) bay-breasted warbler (8) western tanager (35)	AOSC (2009)
2008	West Ells SAGD Project	40 species detected	0.45-0.95 (Shannon diversity index)	bay-breasted warbler broad-winged hawk Cape May warbler pileated woodpecker sora western tanager	Sunshine (2010)
2008	McKay SAGD Pilot Project	34 species detected	1.77-2.54 (Shannon diversity index)	bay-breasted warbler (3) Cape May warbler (10) common yellowthroat (2) western tanager (20)	Southern Pacific (2009)
2008 to 2010	Dover Commercial Project	0.9-6.4 (63 species detected)	0.9-8.5	Cape May warbler (28) common yellowthroat (16) bay-breasted warbler (13) least flycatcher (13) western tanager (8) olive-sided flycatcher (3) brown creeper (30) black-throated green warbler (1)	Dover OPCO (2010)

Table E-42 Breeding Bird Survey Results Within the Region (continued)

Year	Project	Richness [Range][(a)]	Diversity [Range][(a)]	Listed Species [Observed Only]	Reference
2007, 2010 and 2011	CPC Surmont Project	0.7-8.0 (56 bird species detected)	0.2-2.0 (Shannon diversity index)	Cape May warbler (17) common yellowthroat (13) bay-breasted warbler (5) least flycatcher (6) Canada warbler (4) brown creeper (2) barn swallow (1)	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	2.3-3.9 (50 bird species detected)	0.9-2.8 (Shannon diversity index)	bay-breasted warbler (5) brown creeper (5) Canada warbler (1) Cape May warbler (6) common yellowthroat (8) least flycatcher (5) rusty blackbird (1) western tanager (9) western wood-pewee (3)	Cenovus (2011)
2001, 2008, 2009, 2011 and 2012	Canadian Natural Kirby Expansion	0.0-4.0 (53 bird species detected)	0.0-1.3 (Shannon diversity index)	bay-breasted warbler (3) brown creeper (4) Cape May warbler (2) common yellowthroat (16) least flycatcher (7) olive-sided flycatcher (8) rusty blackbird (1) sedge wren[(c)] (1) western tanager (2) western wood-peewee (2)	Present Study

(a) Range represents the minimum and maximum averages observed in different land cover types.

(b) Methods used were different than those from the present study.

(c) Sedge wren was not included as a Species of Concern in the 2011 Wildlife Baseline Report (Canadian Natural 2011)

n/a = Not available.

Table E-43 Common Nighthawk Survey Results Within the Region

Year	Project	Results [total number observed]	Habitat [total number observed; mean relative density ± SD]	Reference
2011	CPC Surmont Project	5	BUu (4; 1.0±1.2) FONG (1; 0.5±0.7)	Unpublished Data
2011 and 2012	Canadian Natural Kirby Expansion	1	FONS (1; 0.1±0.3)	Present Study

Table E-44 Amphibian Survey Results Within the Region

Year	Project	Species	Habitat	Reference
1995	Suncor Steepbank Mine	Wood frog (7)	unknown	Westworth, Brusnyk and Associates (1996b)
		boreal chorus frog (364+)	most within a sedge wetlands type with aspen/poplar	
1996	Shipyard Lake	striped chorus frog (n/a)	unknown	Golder (1996)
		wood frog (n/a)	unknown	
1998	PanCanadian Christina Lake Thermal Project Supplemental	boreal chorus frog (29)	e2, FTNN, FONS, WONS	Golder (2000b)
		western toad (17)	e2, FTNN, FONS	
		wood frog (2)	e2	
2000	Suncor Firebag Project	*Incidentals (1998):* boreal chorus frog (n/a)	d1, d2, FONS, FTNN, h1	Golder (2000e)
		wood frog (n/a)	d2, FONS, FTNN	
2000	Canadian Natural PAW Project	boreal chorus frog (116.5)	MONG, SONS, FONG, FTNN, clearing	Canadian Natural (2000)
		wood frog (40.34)	MONG, SONS, FONG, FTNN, clearing, FONS	
		Canadian toad (6)	MONG, FONG	
		western toad (0.5)	MONG	
2000	PanCanadian Christina Lake Thermal Project	boreal chorus frog (34)	d2, FONS, FTNN, MONG, SONS	Golder (2000b)
		western toad (16)	a1, f1, FTNN, MONG, SONS	
		wood frog (19)	a1, e2, e3, FONS, FTNN, MONG, SONS	
2000	OPTI Long Lake Project	boreal frog (25)	b2, b3, d1, d2, d3, e3, g1, BTNN, FONS, FTNN, SONS, STNN	OPTI (2000)
		wood frog (16)	b3, d2, e3, BTNN, FONS, FTNN, SONS, STNN	
2001	PanCanadian Christina Lake Thermal Project Supplemental	boreal chorus frog (26)	f2, f3, g1, BTNN, FTNN, FONS, FONG, MONG, SONS, clearcut	Golder (2001b)
		wood frog (22)	f2, f3, g1, BTNN, FTNN, FONS, FONG, MONG, SONS, clearcut	
		western toad (19)	f3, g1, BTNN, FTNN, FONS, FONG, MONG, clearcut	
2001	Suncor Firebag Project Supplemental	boreal chorus frog (18)	ephemeral pond, permanent creek	Golder (2000e)
		wood frog (7)	ephemeral pond	
2001	Rio Alto Kirby Project	boreal chorus frog (154)	b1, b4, c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, SONS, STNN, WONN	Rio Alto (2002)
		wood frog (149)	b4, c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, SONS, STNN, WONN	
		western toad (81)	c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, SONS, STNN, WONN	
2001	Petro-Canada Meadow Creek Project	boreal chorus frog (41)	b3, c1, d2, BTNN, FONG, FONS, FTNN, MONG, shrubland, SONS, STNN	Petro-Canada (2001)
		wood frog (82)	b1, b3, c1, d2, g1, BTNN, FONG, FONS, FTNN, MONG, shrubland, SONS, STNN	

Table E-44 Amphibian Survey Results Within the Region (continued)

Year	Project	Species	Habitat	Reference
2001	Shell Jackpine Mine – Phase 1	boreal chorus frog (28)	b2, d2, FTNN, FONG, FONS, SONS/STNN, STNN, SONS, WONN	Golder (2002a)
		wood frog (28)	b2, d2, FTNN, FONG, FONS, SONS/STNN, STNN, SONS, WONN	
2001	Canadian Natural Horizon Project	boreal chorus frog (56)	a1, b3, d1, d2, e1, e2, h1, BTNN, FONS, FTNN, MONG, SONS, STNN, cutblock, landfill	Canadian Natural (2002)
		wood frog (49)	b3, e1, e2, BTNN, FONS, FTNN, MONG, SONS, STNN, cutblock	
		Canadian toad (12)	a1, d2, BTNN, FTNN, SONS, STNN, landfill	
2002	Suncor South Tailings Pond Project	Canadian toad (24) wood frog (17) boreal chorus frog (236)	reclamation vegetation classes mixedwood willow and mixedwood grassland. Wood frog and boreal chorus frog also observed in deciduous willow	Golder (2003b)
2002	Suncor South Tailings Pond	wood frog (15) boreal chorus frog (25)	d2, d3, FTNN, SONS, STNN	Golder (2003c)
2002	Devon Jackfish Project	boreal chorus frog (many) wood frog (many) western toad (many)	n/a	Devon (2003)
2003	Cenovus Christina Lake Thermal Project	boreal chorus frog (194) wood frog (41) western toad (119)	most observations in FTNN and FONS	Golder (2004a)
2004	MEG Christina Lake Regional Project	western toad (28) wood frog (39) boreal chorus frog (35) Canadian toad incidental	most observations in standing water along cutlines, followed by FTNN; also recorded in a1, b1, b3, BTNN, MONG, SONS, WONN	MEG (2005)
2004	Suncor Monitoring Five Year Report	wood frog (53) boreal chorus frog (636) Canadian toad (83)	reclaimed sites	Golder (2004b)
2004	Suncor Voyageur	wood frog (26) boreal chorus frog (32) wood frog (20) boreal chorus frog (24)	various	Golder (2005)
2004 to 2005	Canadian Natural Primrose East Expansion	wood frog (33) boreal chorus frog (98) western toad (5) Canadian toad (6)	c1, d2, d3, FONS, FTNN c1, d2, d3, FONS, FTNN, disturbed FONS, FTNN d2, FONS, FTNN, disturbed	Canadian Natural (2006)

Table E-44 Amphibian Survey Results Within the Region (continued)

Year	Project	Species	Habitat	Reference
2005	Devon Jackfish 2 Project	western toad (many) wood frog (several) boreal chorus frog (many)	n/a	Devon (2006)
2005 to 2006	OPTI/Nexen Long Lake South Project	Canadian toad (46)	most observations in lake and clearcut	OPTI/Nexen (2006)
2006	Suncor Voyageur South	wood frog (34) boreal chorus frog (272) Canadian toad (8)	disturbed (11), various others disturbed (116), various others disturbed (5), e2, FONS, riparian	Suncor (2007)
2006	Cenovus Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G	wood frog (31) boreal chorus frog (79) western toad (39) Canadian toad (2)	FTNN (18), various others FTNN (214), various others FTNN (27), various others FTNN, BTNN	EnCana (2009)
2007	Shell Jackpine Mine Expansion and Pierre River Mine Project	(Jackpine, Pierre River): wood frog (162, 42) boreal chorus frog (1998, 528) western toad (3, 0) Canadian toad (24, 29)	primarily d2, FTNN, SONS primarily FONG, FTNN, MONG BTNN, FTNN primarily c1, FTNN, disturbed	Shell (2007)
2007	Suncor Mine Dump 9 (MD9)	wood frog (53) boreal chorus frog (48) Canadian toad (1)	primarily FTNN, d2 primarily FTNN, d3 disturbed	Suncor (2008)
2008	MEG Christina Lake Regional Project Phase 3	wood frog (39) boreal chorus frog (35) western toad (28)	primarily FTNN primarily FTNN primarily FTNN	MEG (2008)
2008	Total Joslyn Mine Expansion	wood frog (3) boreal chorus frog (687) Canadian toad (2)	SONS and BTNN primarily MONG FTNN	Unpublished Data
2008	Enerplus Kirby Project	wood frog (18) boreal chorus frog (846) western toad (61)	primarily FONS, SONS, and burned wetland primarily FONS, STNN, and burned wetland primarily FONS, and STNN	Enerplus (2008)
2008	Cenovus Narrows Lake Project	wood frog (36) boreal chorus frog (359) western toad (34)	primarily FTNN, secondarily FTNN, STNN primarily FTNN, secondarily BTNN and STNN primarily FTNN, secondarily BTNN, STNN and c1	Cenovus (2010)
2008	West Ells SAGD Project	boreal chorus frog wood frog	n/a	Sunshine (2010)
2009	McKay SAGD Pilot Project	not surveyed	n/a	Southern Pacific (2009)

Table E-44 Amphibian Survey Results Within the Region (continued)

Year	Project	Species	Habitat	Reference
2008 to 2010	Dover Commercial Project	wood frog (40) boreal chorus frog (171) western toad (2) Canadian toad (1)	primarily BTNN, FONS and FTNN primarily BTNN, FONS and FTNN FONS, FTNN FONS	Dover OPCO (2010)
2007, 2010 and 2011	CPC Surmont Project	wood frog (997) boreal chorus frog (1,196) Canadian toad (79)	highest density in MONG, lakes and WONN highest density in FTNI, MONG and b3 highest density in b3, WONN and e3	Unpublished Data
2010 to 2011	Cenovus Pelican Lake Grand Rapids Project	boreal chorus frog (704) western toad (40) wood frog (7)	primarily in borrow pits primarily in borrow pits and BTNN highest number detected in BTNN	Cenovus (2011)
2001, 2008, 2011 and 2012	Canadian Natural Kirby Expansion	wood frog (1,028) boreal chorus frog (2,958) western toad (316) [(a)]	highest density in MONG highest density in e2 highest density in MONG	Present Study

n/a = Not available.

1 REFERENCES

Alsands (Alsands Energy Limited). 1978. *Environmental Impact Assessment Presented to Alberta Environment in Support of an Oil Sands Mining Project.* Calgary, AB. 401 pp.

AOSC (Athabasca Oil Sands Corp.). 2009. *Application for Approval of the MacKay River Commercial Project*. Submitted to Alberta Energy Resources Conservation Board and Alberta Environment.

AXYS (AXYS Environmental Consulting Ltd.). 1999. *Track Surveys for the AEC Foster Creek SAGD Project*. Prepared for EBA Engineering Consultants Ltd. 15 pp.

AXYS. 2000a. *Winter Ungulate Surveys for the Proposed Petro-Canada MacKay River Project*. Prepared for Petro-Canada Oil and Gas. 16 pp.

AXYS. 2000b. *Snowtracking Survey for the Proposed Muskeg River Pipeline*. February 2000. Prepared for ATCO Pipelines. 14 pp.

Bibaud, J.A. and T. Archer. 1973. *Fort McMurray Ungulate Survey of the Mineable Portion of the Bituminous (Tar) Sands Area-No. 1*. Alberta Recreation, Parks and Wildlife. Edmonton, AB.

Bovar–Concord Environmental. 1995. *Environmental Impact Assessment for the SOLV–EX Oil Sands Co–Production Experimental Project.* Prepared for SOLV–EX Corporations by BOVAR–CONCORD Environmental in Association with AGRA Earth and Environmental, Hydroconsult EN3 Services Ltd., Fedirchuk, McCollough & Associates Ltd. and RL&L Environmental Services Ltd.

Boyd, M. 1977. *Analysis of Fur Production Records by Individual Furbearing Species for Registered Traplines in Alberta*. 1970–1975. Alberta Fish and Wildlife Division. Edmonton, AB. 72 pp.

BP Resources (BP Resources Canada Limited, Environmental Management Associates and the DPA Group Inc.). 1985. *Wolf Lake Development Plan, Application to Alberta Energy Resources Conservation Board for Approval of Wolf Lake 2. Volumes I and II*. Environmental Impact Assessment. Prepared for BP Resources Canada Limited and Petro-Canada Inc. Calgary, AB.

Canadian Natural (Canadian Natural Resources Ltd.). 2000. *Primrose and Wolf Lake (PAW) In-Situ Oil Sands Expansion Project. Volumes I to VI*. October 2000. Prepared by Golder Associates Ltd. Calgary, AB.

Canadian Natural. 2002. *Horizon Oil Sands Project - Application for Approval. Volume 1* Prepared by Canadian Natural Resources Limited. Volumes 2, 3, 4, 5, 6, 7 and 8. Prepared by Golder Associates Ltd. for Canadian Natural Resources Limited. Submitted to Alberta Energy and Utilities Board and Alberta Environment. June 2002. Calgary, AB.

Canadian Natural. 2006. *Primrose In-Situ Oil Sands Project. Primrose East Expansion Application for Approval. Volumes 1 to 6*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Prepared by Golder Associates Ltd. Calgary, AB. Submitted January 2006.

Canadian Natural. 2007. *Kirby In-Situ Oil Sands Project Application for approval. Volumes 1-6*. Submitted to Energy Resources Conservation Board and Alberta Environment. September 2007. Calgary, AB.

Canadian Natural. 2011. *Kirby In-Situ Oil Sands Expansion Project Application for Approval. Volumes 1-6*. Submitted to Energy Resources Conservation Board and Alberta Environment and Water. December 2011. Calgary, AB.

Cenovus (Cenovus FCCL Ltd). 2010. *Application for Approval of the Cenovus Narrows Lake Project.* Integrated Application and Environmental Impact Assessment. Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment, June 2010. Calgary, AB.

Cenovus. 2011. *Application for Approval of the Pelican Lake Grand Rapids. Integrated Application and Environmental Impact Assessment.* Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment and Water, December 2011. Calgary, AB.

Conor Pacific (Conor Pacific Environmental Technologies Inc). 1998. *Environmental Impact Assessment for the Syncrude Canada Ltd. Mildred Lake Upgrader Expansion Project. Vol IIb*. Prepared for Syncrude Canada Ltd.

Cook, R.D. and J.O. Jacobsen. 1978. *The 1977 Fort McMurray AOSERP Moose Census: Analysis and Interpretations of Results*. Interdisciplinary Systems Ltd. 43 pp.

Crampton, L.H. and R.M.R. Barclay. 1998. *Selection of Roosting and Foraging Habitat by Bats in Different-Aged Aspen Mixedwood Stands*. Conservation Biology. 12:1347-1358.

Devon (Devon Canada Corporation). 2003. *Application for the Approval of the Devon Jackfish Project Including Supplementary Information Request, Volume 2*. Submitted to: Alberta Energy and Utilities Board and Alberta Environment. November 2003. Calgary, AB.

Devon. 2006. *Application for the Approval of the Devon Jackfish 2 Project*. Submitted to the Alberta Energy and Utilities Board and Alberta Environment. September 2006. Calgary AB.

Dover OPCO (Dover Operating Corp.). 2010. *Application for Approval of Dover Operating Corp. Dover Commercial Project. Volumes 1 to 6*. Submitted to Alberta Energy Resources Conservation Board and Alberta Environment. December 2010. Volume 4, Aquatic Resources updated and resubmitted February 28, 2011. Calgary, AB.

Duncan, J.A., T.R. Eccles and R.E. Salter. 1986. *Sign Surveys of Mammal Populations in the OSLO Oil Sands Sign Survey Study Area, December 1985 and February 1986*. Prepared for Esso Resources Canada Ltd. by LGL Ltd. Environmental Research Associates. Calgary, AB.

EnCana (EnCana FCCL Ltd.). 2009. *Application for Approval of the EnCana Christina Lake Thermal Expansion Project, Phases 1E, 1F and 1G. Integrated Application and Environmental Impact Assessment*. Submitted to the Alberta Energy Resources Conservation Board and Alberta Environment, October 2009. Calgary, AB.

Enerplus (Enerplus Resources Fund). 2008. *Kirby Oil Sands Project Phase I Wildlife Environmental Baseline and Assessment Report*. Prepared by Golder Associates Ltd.

Esso (Imperial Oil Resources Ltd.). 1979. *Final Environmental Impact Assessment, Cold Lake Production Project. Volumes I, II and III*. Calgary, AB.

Esso. 1997. *Application for Approval of the Cold Lake Expansion Project. Volume 2*. Environmental Impact Assessment, Part 1: Biophysical and Resource Use Assessment. Prepared by AXYS Environmental Consulting Ltd.

Fort McKay Environmental Services Ltd. 1996. *Survey of Wildlife, Including Aquatic Mammals, Associated with Riparian Habitat on the Syncrude Canada Ltd*. Aurora Mine Environmental Impact Assessment Local Study Area. Fort McKay, AB.

Fuller, T.K. and L.B. Keith. 1977. *Wolf, Woodland Caribou and Black Bear Population Dynamics in Northeastern Alberta Interim Report Prepared for AOSERP Project TF1.1*. Edmonton, AB.

Fuller, T.K. and L.B. Keith. 1980a. *Summer Ranges, Cover-Type Use and Denning of Black Bears Near Fort McMurray, AB*. Canadian Field Naturalist. 94(1):80-82.

Fuller, T. K. and L. B. Keith. 1980b. *Wolf Population Dynamics and Prey Relationships in Northeastern Alberta*. Journal of Wildlife Management. 44:583-602.

Fuller, T.K. and L.B. Keith. 1981. *Woodland Caribou Dynamics in Northeastern Alberta*. Journal of Wildlife Management. 45:197-213.

Golder (Golder Associates Ltd.). 1996. *Shipyard Lake Environmental Baseline Study*. Prepared for Suncor Energy Inc., Oil Sands Group. Fort McMurray, AB. 22 pp.

Golder. 1997a. *Wildlife Baseline Conditions for Shell's Proposed Muskeg River Mine Project*. Prepared for Shell Canada Limited. Calgary, AB. 116 pp. + Appendices.

Golder. 1997b. *Winter Wildlife Surveys Conducted on Shell Canada's Lease 13*. March 1997. Prepared for Shell Canada Limited. Calgary, AB.

Golder. 1998a. *Winter Wildlife Surveys–Steepbank River Valley, Shipyard Lake and Leases 25 and 29 Uplands*. Prepared for Suncor Energy Inc., Oil Sands. Fort McMurray, AB. 51 pp. + Appendices.

Golder. 1998b. *Wildlife Baseline Conditions for Project Millennium*. Prepared for Suncor Energy Inc., Oil Sands. Fort McMurray, AB.

Golder. 1999a. *Suncor Oil Sands Project Wildlife Monitoring Program 1998-1999*. Submitted to Suncor Energy Inc., Oil Sands. Fort McMurray, AB. July 1999. 37 pp. + Appendices.

Golder. 1999b. *1999 Mobil Lease 36 Ungulate Aerial Survey*. Prepared for Mobil Oil Canada Properties. Calgary, AB.

Golder. 2000a. *Winter Wildlife Surveys for the TrueNorth Fort Hills Oil Sands Project*. Prepared for TrueNorth Exploration Canada Ltd. Calgary, AB.

Golder. 2000b. *Christina Lake Thermal Project, Phase 1 - Wildlife, Wetlands and Rare Plant Assessment Update*. Prepared for PanCanadian Petroleum Ltd. Calgary, AB. Submitted August 2000.

Golder. 2000c. *Lease 13 West Albian Sands Winter Wildlife Track Count Surveys*. Submitted to Albian Sands Energy Inc., Fort McMurray, AB. August 2000. 40 pp. + Appendices.

Golder. 2000d. *Suncor Millennium and Steepbank Mine Projects Wildlife Monitoring Program & Wildlife Assessment Update 2000*. Submitted to Suncor Energy Inc., Oil Sands. Fort McMurray, AB. August 24, 2000. 32 pp. + Appendices.

Golder. 2000e. *Firebag In-Situ Oil Sands Application Supplemental Information - Supplemental Wildlife Baseline Surveys*. Submitted to Suncor Energy Inc. 21 pp.

Golder. 2001a. *Lease 13 West Albian Sands Winter Track Count Surveys to Investigate Potential Wildlife Movement Corridors*. Prepared for Albian Sands Energy Inc. Fort McMurray, AB. 72 pp. + Appendices.

Golder. 2001b. *Christina Lake Thermal Project, Phase 1 - Wetlands Monitoring Program*. Prepared for PanCanadian Petroleum Ltd. Calgary, AB. Submitted November 2001.

Golder. 2002a. *Wildlife Environmental Setting for Jackpine Mine – Phase 1*. Prepared for Shell Canada Limited. 149 pp.

Golder. 2002b. *Winter Aerial Ungulate Survey for the Petro-Canada Meadow Creek Project*. Prepared for Petro-Canada. Prepared by Golder Associates Ltd. June 2002. 21 pp. + Appendices.

Golder. 2003a. *2003 Winter Aerial Caribou Survey for the Petro-Canada Meadow Creek Project*. Prepared for Petro-Canada. Prepared by Golder Associates Ltd. March 2003. 25 pp. + Appendices.

Golder. 2003b. *Suncor South Tailings Pond (STP) Project. Terrestrial Vegetation, Wetlands and Forest Resources Baseline Report*. Prepared for Suncor Energy Inc. December 2003. Calgary, AB. 75 pp. + Appendices.

Golder. 2003c. *2002 Suncor Energy Wildlife Monitoring Program and Wildlife Assessment Update Year 4*. Prepared for Suncor Energy Inc., Fort McMurray, AB. Prepared by Golder Associates Ltd.

Golder. 2004a. *Christina Lake Thermal Project: Wildlife and Wetlands Monitoring: Year 2*. Prepared for EnCana Corporation, Oil Sands. February 2004.

Golder. 2004b. Suncor *Energy Wildlife Monitoring Program and Wildlife Assessment Update: Years 1999 - 2003*. Prepared for Suncor Energy Inc. Fort McMurray, AB. 23 pp.

Golder. 2004c. *2004 Suncor Energy Wildlife Monitoring Program and Wildlife Assessment Update Year 5*. Prepared for Suncor Energy Inc., Fort McMurray, AB. Prepared by Golder Associates Ltd.

Golder. 2005. *Wildlife Environmental Setting Report for the Suncor Voyageur Project*. Prepared for Suncor Energy Inc. Calgary, AB. 163 pp.

Golder. 2007a. *Wildlife Environmental Setting Report for the Suncor Voyageur South Project*. Prepared for Suncor Energy Inc. Fort McMurray, AB. Submitted July 2007.

Golder. 2007b. *Wildlife Environmental Setting Report for the Millennium Mine Dump 9 Project*. Prepared for Suncor Energy Inc. Fort McMurray, AB. Submitted November 2007.

Golder. 2009a. *Firebag 2008 Wildlife Monitoring Program Annual Report*. Prepared for Suncor Energy Inc. Fort McMurray, AB. Submitted March 2009.

Golder. 2009b. *Jackpine Mine Expansion and Pierre River Mine Project Environmental Impact Assessment Follow-up 2009 Yellow Rail Surveys*. Prepared for Shell Canada Energy. Calgary, AB. Submitted October 2009.

Golder. 2010. *Firebag 2009 Wildlife Monitoring Program Annual Report*. Prepared for Suncor Energy Inc. Fort McMurray, AB. Submitted March 2010.

Green, J. 1980. *Small Mammal Populations of Northeastern Alberta. I*. Populations in Natural Habitats. Alberta Oil Sands Environmental Research Program. Project L.S. 7.1.2.

Green, J. E. 1979. *The Ecology of Five Major Species of Small Mammals in the AOSERP Study Area: A Review. Project LS 7.1.2.* LGL Limited, Environmental Research Associates. Alberta Oil Sands Environmental Research Program (AOSERP) Report 72.

Gulf (Gulf Canada Resources Ltd.). 2001. *Application for the Approval of the Surmont In-Situ Oil Sands Project*. Prepared for Gulf Canada Resources Limited by Colt Engineering Corporation, AXYS Environmental Consulting Ltd., Campbell & Associates Ltd., Matrix Solutions Inc. and Nichols Applied Management. March 2001. Volumes 1 to 3 + 6 Appendices.

Hauge, T.M. and L.B. Keith. 1981. *Dynamics of Moose Populations in Northeastern Alberta*. Journal of Wildlife Management. 45:573-597.

Hubbs, A. and T. Schowalter. 2003. *Survey of Bats in Northeastern Alberta*. Alberta Species at Risk Report No. 68. Fish and Wildlife Division, Alberta Sustainable Resource Development. Edmonton, AB. 18 pp.

Imperial Oil. 2008. *Kearl Oil Sands Project 2008 Yellow Rail Surveys*. Prepared for Imperial Oil Resources Ventures Limited by Golder Associates Ltd. Calgary, AB. 17 pp.

MEG (MEG Energy Corp.). 2005. *Application for Approval of the Christina Lake Regional Project. Volumes 1 to 5*. Submitted to Alberta Environment and Alberta Energy and Utilities Board. Calgary, AB. Submitted August 2005.

MEG. 2008. *Christina Lake Regional Project - Phase 3 Wildlife Environmental Setting Report*. Prepared for MEG Energy Corp., Calgary, AB.

Michielsen, J. and A. Radvanyi. 1979. *Great Canadian Oil Sands Small Mammal Study, In Accordance with SA No. 571280*.

Moses, R.A. and S. Boutin. 2001. *The Influence of Clear-Cut Logging and Residual Leave Material on Small Mammal Populations in Aspen-Dominated Boreal Mixedwoods*. Canadian Journal of Forest Research. 31:483-495.

Murray, L. and R.W. Pauls. 1983. *Beaver and Muskrat Aerial Survey, Syncrude Project Area*. Prepared for Syncrude Canada Ltd.

North American (North American Oil Sands Corporation). 2007. *Application for Approval. Kai Kos Dehseh SAGD Project, Environmental Baseline and Impact Assessment, Wildlife*. Volume 4, Section 11. Submitted to EUB August 21, 2007.

OPTI (OPTI Canada Inc.). 2000. *Long Lake Project Application for Approval to Alberta Energy and Utilities Board and to Alberta Environment*. Volume 1 (Application) and Volumes 2 to 7 (EIA). December 2000. Calgary, AB.

OPTI/Nexen (OPTI Canada Inc. & Nexen Inc.). 2006. *Application for Approval of the Long Lake South Project, Volumes 1 to 5*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Calgary, AB. Submitted December 2006.

Patriquin, K.J. 2001. *Ecology of a Bat Community in Harvested Boreal Forest in Northwestern Alberta*. M.Sc. Thesis, University of Calgary. Calgary, AB.

Pauls, R.W. 1984. Beaver and Muskrat Survey, Syncrude Project Area, October 1984. Prepared for Syncrude Canada Ltd.

Pauls, R.W. 1989. *Beaver and Muskrat Survey, Syncrude Project Area, October 1988.* Internal Report. Prepared by Syncrude Canada Ltd.

Pauls, R.W. 1991. *Beaver and Muskrat Survey, Syncrude Project Area. October 1991.* Internal Report Prepared by Syncrude Canada Ltd. 8 pp.

Pauls, R.W. and B.D. Arner. 1987. *Beaver and Muskrat Survey*. *Syncrude Project Area. October 1986 Internal Report*. Prepared by Syncrude Canada Ltd. 8 pp.

Penner, D.F. 1976. *Preliminary Baseline Investigations of Furbearing and Ungulate Mammals Using Lease 17*. Renewable Resources Consulting Services Ltd. Environmental Research Monograph 1976–3. Edmonton, AB.

Petro-Canada (Petro-Canada Oil and Gas). 2001. *Application for the Approval of the Meadow Creek Project*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. November 2001.

Rio Alto (Rio Alto Exploration Ltd.). 2002. *Kirby Project Application for Approval to Alberta Energy and Utilities Board and to Alberta Environment*. Volumes 1,2,3,5,6 and 7. Prepared by Golder Associates Ltd. Calgary, AB.

Ruff, R.L., B.F. Young and B.O. Pelchat. 1976. *A Study of the Natural Regulatory Mechanisms Acting on an Unhunted Population of Black Bears Near Cold Lake, Alberta*. Unpublished Report. Alberta Department of Recreation Parks and Wildlife, Fish and Wildlife Division.

Salter, R.E., J.A. Duncan and J.E. Green. 1986. *Surveys of Ungulate Populations in the OSLO Oil Sands Ungulate Study Area*. December 1985 and 1986. LGL Ltd. (ed.). Prepared for Esso Resources Canada Ltd. Calgary AB.

Schowalter, T. 2001. *Summary of Observations Made During Bat Surveys in Northeastern Alberta*. 44 pp.

Searing, G.F. 1979. *Distribution, Abundance, and Habitat Association of Beavers, Muskrats, Mink, and River Otters in the AOSERP Study Area, Northeastern Alberta. AOSERP Report No. 73.* Prepared by LGL Limited, Environmental Research Associates. 119 pp.

Shell (Shell Canada Limited). 2007. *Jackpine Mine Expansion & Pierre River Mine Project Application and Environmental Impact Assessment. Volume 5.* Submitted to Alberta Energy and Utilities Board and Alberta Environment, December 2007. Calgary, AB.

Skinner, D.L. and D.A. Westworth. 1981. *Preliminary Studies of Mammals in EnCana Christina Lake Expansion Project 80 Study Area*. Prepared for Canstar Oil Sands Ltd. Edmonton AB. 62 pp.

Southern Pacific (Southern Pacific McKay Resource Corporation). 2009. *Application for the Southern Pacific Resource Corp*. *McKay SAGD Project*. Submitted to Alberta Energy and Utilities Board and Alberta Environment, May 2009. Calgary, AB.

Stelfox, J.B. (Editor). 1995. *Relationships Between Stand Age, Stand Structure and Biodiversity in Aspen Mixedwood Forests in Alberta*. Jointly Published by Alberta Environmental Centre (AECV95-R1), Vegreville, AB and Canadian Forest Service (Project No. 0001A), Edmonton, AB. 308 pp.

Suncor (Suncor Energy Inc.). 1995. *Burnt Lake Thermal Project*. Application to Energy Resources Conservation Board. Volume 2: Environmental Impact Assessment.

Suncor. 1998. *Project Millennium Application. Volumes 1, 2A, 2B, 2C and 2D*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Calgary, AB. Submitted April 1998.

Suncor. 2000. Firebag In-Situ Oil Sands Project. *Application for Conservation and Reclamation Approval and Water Act Notification for the Utility Corridor*. May 2000. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Prepared by Suncor Energy Inc. and Golder Associates Ltd. Calgary, AB.

Suncor. 2005. *Voyageur Project Application and Environmental Impact Assessment*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volumes 1A, 1B, 2, 3, 4, 5 and 6. Fort McMurray, AB. Submitted March 2005.

Suncor. 2007. *Wildlife Baseline Report for the Suncor Voyageur South Project*. Prepared for Suncor Energy Inc. Fort McMurray, AB.

Suncor. 2008. *Mine Dump 9 (MD9) Project Application and Environmental Assessment. Volumes 1 and 2*. Submitted to Alberta Energy and Utilities Board and Alberta Environment. March 2008. Fort McMurray, AB.

Sunshine (Sunshine Oil Sands Ltd.). 2010. *Application for the Sunshine Oil Sands Ltd. West Ells SAGD Project*. Submitted to Alberta Energy and Utilities Board and Alberta Environment, March 2010. Calgary, AB.

Syncrude (Syncrude Canada Ltd.). 1984. *Biophysical Impact Assessment for the New Facilities at the Syncrude Canada Ltd. Mildred Lake Plant*. Edmonton, AB.

TrueNorth (TrueNorth Energy). 2001. *Application for Approval of the Fort Hills Oil Sands Project. Volume 5c: Environmental Baseline Study*. Prepared by AXYS Environmental Consulting Ltd. and Golder Associates Ltd.

URSUS and Komex (URSUS Ecosystem Management Ltd. and Komex International Ltd.). 1997. *Wildlife Field Surveys. Mobil Oil Canada Lease 36 Baseline Study*. Prepared for Mobil Oil Canada. Calgary, AB. 29 pp. + Appendices.

Vonhof, M.J. and D. Hobson. 2001. *Survey of the Bats of Central and Northwestern Alberta*. Alberta Sustainable Resource Development, Fish and Wildlife Service, Alberta Species At Risk Report No.4. Edmonton, AB. 33 pp.

Westworth and Associates (Westworth and Associates Environmental Ltd.). 1979. *Review of Mammal Populations on Lease No. 17 and Vicinity*. Prepared for Syncrude Canada Ltd. Professional Paper 1979–2. 26 pp.

Westworth, Brusnyk and Associates Ltd. 1996a. *Wildlife Inventory of Oil Sands Leases 12, 13 and 34*. Prepared for Syncrude Canada Ltd. 50 pp.

Westworth, Brusnyk and Associates Ltd. 1996b. *Impact Analysis Suncor Steepbank Mine Environmental Wildlife Component*. Prepared for Suncor Inc., Oil Sands Group. Edmonton, AB.

Westworth, Brusnyk and Associates. 1996c. *Abundance and Distribution of Moose in the Suncor Study Area*. Prepared for Suncor Inc., Oil Sands Group. Edmonton, AB.

Westworth, D. A. 1980. *Surveys of Moose Populations in the Vicinity of the Syncrude Development, Winter 1979-1980*. Prepared for Syncrude Canada Ltd. 13 pp.

Westworth, D.A. and L.M. Brusnyk. 1982. *Wildlife Resources of the Canstar Leases: Terrestrial Furbearers*. Prepared for Canstar Oil Sands Ltd.

Westworth. 2001. *Muskeg River Mine Project Wildlife Assessment Update: Bird of Prey and Amphibian Inventories*. Prepared for Albian Sands Energy Inc.

Young, D. A. and C. P. Bjornson. 1985. *Wildlife Investigations in the Vicinity of the Wolf Lake Development, May-October 1985.* Environmental Management Associates (ed.). Prepared for BP Resources Canada Limited.

Young, B.F. and R.L. Ruff. 1982. *Population Dynamics and Movements of Black Bears in East Central Alberta*. Journal of Wildlife Management. 46:845-860.

ATTACHMENT F

BREEDING SONGBIRD RESULTS IN THE OIL SANDS REGION

Table F-1 Breeding Bird Average Relative Abundance (± Standard Deviation) by Land Cover Type in the Oil Sands Region, 2001 to 2011

Habitat Group	burn		clearcut	coniferous jack pine−black spruce				coniferous white spruce			deciduous aspen−balsam poplar				linear development (vegetated)	mixedwood jack pine−aspen	mixedwood aspen−white spruce				non-linear development (vegetated)		non-treed open wetland			non-treed shrubby wetland					treed bog		treed fen			treed swamp		Overall Average or Total	Number of Birds
Map Code[a]	BUu	BUw	CC	a1	b4	c1	g1	d3	e3	f3	b2	d1	e1	f1	cutline	b1	b3	d2	e2	f2	clearing	wellpad	FONG	MONG	WONN	BONS	FONS	riparian	Sh	SONS	BFNN	BTNN	FFNN	FTNN	FTPN	h1	STNN		
Number of Point Counts	18	7	9	65	15	127	175	28	10	15	13	167	20	7	6	87	48	293	17	19	4	1	38	10	5	1	137	1	23	91	1	274	3	354	1	37	34	2,161	
alder flycatcher	0.67 (0.69)	0.29 (0.49)	0.33 (0.71)	0.02 (0.12)	-	0.02 (0.20)	0.02 (0.18)	0.04 (0.19)	-	0.13 (0.52)	0.08 (0.28)	0.04 (0.22)	-	-	0.17 (0.41)	-	0.02 (0.14)	0.01 (0.13)	-	0.05 (0.23)	0.50 (0.58)	-	0.16 (0.49)	0.10 (0.32)	0.20 (0.45)	-	0.17 (0.41)	1 (na)	0.74 (0.75)	0.60 (0.71)	-	0.03 (0.16)	0.33 (0.58)	0.05 (0.21)	-	0.03 (0.16)	0.29 (0.68)	0.08 (0.33)	182
American redstart	-	0.14 (0.38)	-	-	-	<0.01 (0.09)	-	-	-	-	-	0.07 (0.32)	0.25 (0.55)	-	-	-	0.02 (0.14)	0.02 (0.15)	0.12 (0.33)	0.11 (0.32)	0.25 (0.50)	-	0.05 (0.32)	-	-	-	<0.01 (0.09)	-	0.04 (0.21)	0.12 (0.36)	-	-	-	<0.01 (0.08)	-	-	0.09 (0.29)	0.02 (0.17)	52
American robin	0.17 (0.51)	-	-	0.02 (0.12)	-	0.02 (0.15)	<0.01 (0.08)	-	0.10 (0.32)	0.07 (0.26)	0.08 (0.28)	0.07 (0.29)	-	-	-	-	-	0.02 (0.14)	-	0.05 (0.23)	-	-	0.11 (0.45)	-	-	-	<0.01 (0.09)	-	0.04 (0.21)	0.02 (0.15)	-	<0.01 (0.09)	-	<0.01 (0.08)	-	0.03 (0.16)	0.03 (0.17)	0.02 (0.16)	43
barn swallow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.09)	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
bay-breasted warbler	-	-	-	0.06 (0.24)	0.13 (0.35)	<0.01 (0.09)	<0.01 (0.08)	0.14 (0.36)	0.10 (0.32)	0.40 (0.63)	-	0.02 (0.19)	0.05 (0.22)	0.14 (0.38)	-	0.06 (0.28)	0.06 (0.24)	0.12 (0.36)	0.12 (0.33)	0.16 (0.37)	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.10)	-	<0.01 (0.05)	-	0.14 (0.42)	0.03 (0.17)	0.04 (0.21)	83
black-and-white warbler	-	-	-	0.03 (0.17)	0.07 (0.26)	<0.01 (0.09)	0.02 (0.13)	0.04 (0.19)	-	0.07 (0.26)	0.15 (0.38)	0.02 (0.15)	0.15 (0.37)	-	-	0.01 (0.11)	0.04 (0.20)	0.03 (0.16)	0.18 (0.39)	0.11 (0.32)	0.25 (0.50)	-	-	-	-	-	0.02 (0.15)	-	0.13 (0.46)	0.10 (0.30)	-	<0.01 (0.06)	-	<0.01 (0.05)	-	0.03 (0.16)	0.09 (0.29)	0.03 (0.16)	56
blackburnian warbler	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
black-capped chickadee	0.11 (0.47)	-	-	0.02 (0.12)	-	0.02 (0.15)	-	0.04 (0.19)	-	-	-	0.03 (0.20)	-	0.14 (0.38)	-	0.01 (0.11)	0.02 (0.14)	0.03 (0.22)	0.06 (0.24)	-	-	-	-	-	-	-	0.03 (0.24)	-	-	0.04 (0.25)	-	0.01 (0.17)	-	<0.01 (0.05)	-	-	-	0.02 (0.16)	39
blackpoll warbler	-	-	-	-	-	0.05 (0.21)	0.03 (0.20)	-	-	-	-	0.01 (0.11)	-	-	-	-	-	<0.01 (0.06)	-	0.05 (0.23)	-	-	-	-	-	-	<0.01 (0.09)	-	-	0.05 (0.23)	-	0.02 (0.13)	-	0.02 (0.14)	-	-	-	0.02 (0.13)	33
black-throated green warbler	-	-	-	-	-	-	-	-	0.10 (0.32)	-	-	-	0.25 (0.44)	-	-	-	-	<0.01 (0.06)	-	0.05 (0.23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	8
blue-headed vireo	-	-	-	0.03 (0.17)	0.07 (0.26)	-	0.01 (0.11)	0.04 (0.19)	-	0.13 (0.35)	-	0.02 (0.13)	0.10 (0.31)	-	-	0.02 (0.15)	0.04 (0.20)	0.02 (0.15)	0.06 (0.24)	0.05 (0.23)	-	-	-	-	-	-	-	-	0.04 (0.21)	0.01 (0.10)	-	-	-	<0.01 (0.08)	-	-	-	0.01 (0.12)	30
boreal chickadee	-	-	-	0.03 (0.17)	-	0.02 (0.15)	0.02 (0.15)	0.18 (0.48)	-	0.07 (0.26)	-	-	-	0.14 (0.38)	-	0.05 (0.30)	0.10 (0.42)	0.05 (0.29)	-	-	-	-	-	-	-	-	-	-	0.09 (0.42)	0.04 (0.25)	-	0.06 (0.42)	-	0.06 (0.29)	-	0.08 (0.49)	-	0.04 (0.27)	88
Brewer's blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.11)	-	-	-	<0.01 (0.04)	2
brown creeper	-	-	-	-	-	<0.01 (0.09)	<0.01 (0.08)	0.04 (0.19)	-	-	0.08 (0.28)	0.04 (0.23)	0.10 (0.31)	-	-	0.02 (0.15)	-	0.05 (0.24)	-	0.05 (0.23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.16)	-	0.02 (0.13)	33
Canada warbler	-	-	-	-	-	-	-	0.04 (0.19)	0.10 (0.32)	-	-	0.03 (0.20)	0.15 (0.37)	0.14 (0.38)	-	0.01 (0.11)	0.04 (0.20)	0.03 (0.20)	0.12 (0.49)	0.05 (0.23)	0.25 (0.50)	-	-	-	-	-	-	-	-	0.01 (0.10)	-	-	-	-	-	0.03 (0.16)	-	0.01 (0.13)	30
Cape May warbler	-	-	-	-	0.13 (0.35)	<0.01 (0.09)	0.06 (0.29)	0.32 (0.48)	0.50 (0.53)	0.20 (0.41)	-	0.01 (0.11)	0.10 (0.31)	-	-	0.07 (0.25)	0.08 (0.28)	0.08 (0.26)	-	-	-	-	0.03 (0.16)	-	-	-	-	-	-	-	-	0.03 (0.22)	-	<0.01 (0.09)	-	0.16 (0.37)	0.03 (0.17)	0.04 (0.20)	85
cedar waxwing	0.17 (0.51)	-	0.22 (0.67)	-	-	-	-	-	-	-	-	0.01 (0.11)	-	-	-	0.01 (0.11)	-	0.02 (0.23)	-	-	-	-	-	-	-	-	0.01 (0.17)	-	-	0.04 (0.29)	-	<0.01 (0.06)	-	-	-	-	0.03 (0.17)	0.01 (0.14)	23
chipping sparrow	0.22 (0.43)	0.57 (0.79)	0.22 (0.44)	0.17 (0.42)	0.07 (0.26)	0.15 (0.38)	0.20 (0.46)	0.21 (0.57)	0.20 (0.42)	0.67 (0.82)	0.15 (0.38)	0.15 (0.41)	0.10 (0.31)	-	-	0.18 (0.42)	0.38 (0.64)	0.15 (0.40)	0.18 (0.39)	0.32 (0.58)	1.0 (2.00)	2 (na)	0.18 (0.46)	-	-	1 (na)	0.42 (0.60)	-	0.26 (0.45)	0.22 (0.47)	1 (na)	0.31 (0.54)	0.33 (0.58)	0.33 (0.54)	1 (na)	0.43 (0.65)	0.41 (0.56)	0.25 (0.50)	544
clay-coloured sparrow	0.06 (0.24)	-	0.11 (0.33)	-	0.07 (0.26)	-	-	-	-	-	-	<0.01 (0.08)	-	-	0.17 (0.41)	-	-	-	-	-	0.25 (0.50)	-	0.08 (0.27)	-	-	-	0.07 (0.34)	1 (na)	0.04 (0.21)	0.19 (0.54)	-	<0.01 (0.09)	-	<0.01 (0.08)	-	-	-	0.02 (0.17)	42
common yellowthroat	0.06 (0.24)	0.29 (0.76)	-	-	-	-	-	-	0.10 (0.32)	-	-	<0.01 (0.08)	0.05 (0.22)	0.14 (0.38)	-	-	-	<0.01 (0.06)	0.06 (0.24)	-	-	-	0.11 (0.31)	0.20 (0.42)	-	-	0.16 (0.39)	-	0.13 (0.34)	0.41 (0.68)	-	<0.01 (0.09)	-	0.02 (0.17)	-	-	0.18 (0.39)	0.04 (0.23)	93
Connecticut warbler	-	-	-	-	-	-	-	0.04 (0.19)	0.10 (0.32)	-	-	0.05 (0.23)	-	-	-	-	0.02 (0.14)	0.03 (0.17)	0.06 (0.24)	0.05 (0.23)	-	-	-	-	-	-	-	-	-	0.01 (0.10)	-	-	-	-	-	-	0.03 (0.17)	0.01 (0.11)	25
dark-eyed junco	0.11 (0.32)	0.29 (0.49)	-	0.20 (0.51)	-	0.21 (0.50)	0.18 (0.44)	-	0.10 (0.32)	0.07 (0.26)	0.15 (0.38)	0.02 (0.13)	-	-	-	0.08 (0.31)	-	0.03 (0.19)	-	0.05 (0.23)	-	-	0.05 (0.23)	0.30 (0.67)	-	-	0.12 (0.39)	-	0.13 (0.34)	0.11 (0.35)	-	0.32 (0.61)	-	0.29 (0.55)	-	0.16 (0.44)	0.12 (0.33)	0.16 (0.43)	337
eastern kingbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.19)	-	-	0.01 (0.10)	-	-	-	<0.01 (0.05)	-	-	-	<0.01 (0.06)	5
eastern phoebe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
evening grosbeak	-	-	-	-	-	-	-	0.04 (0.19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1

Table F-1 Breeding Bird Average Relative Abundance (± Standard Deviation) by Land Cover Type in the Oil Sands Region, 2001 to 2011 (continued)

Habitat Group	burn		clearcut	coniferous jack pine–black spruce				coniferous white spruce			deciduous aspen–balsam poplar				linear development (vegetated)	mixedwood jack pine–aspen	mixedwood aspen–white spruce				non-linear development (vegetated)		non-treed open wetland			non-treed shrubby wetland					treed bog		treed fen			treed swamp		Overall Average or Total	Number of Birds
Map Code[(a)]	BUu	BUw	CC	a1	b4	c1	g1	d3	e3	f3	b2	d1	e1	f1	cutline	b1	b3	d2	e2	f2	clearing	wellpad	FONG	MONG	WONN	BONS	FONS	riparian	Sh	SONS	BFNN	BTNN	FFNN	FTNN	FTPN	h1	STNN		
Number of Point Counts	18	7	9	65	15	127	175	28	10	15	13	167	20	7	6	87	48	293	17	19	4	1	38	10	5	1	137	1	23	91	1	274	3	354	1	37	34	2,161	
fox sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.05)	-	-	-	<0.01 (0.02)	1
golden-crowned kinglet	-	-	-	0.02 (0.12)	0.13 (0.35)	<0.01 (0.09)	0.02 (0.13)	0.11 (0.31)	0.20 (0.63)	-	-	0.01 (0.11)	-	-	-	-	0.06 (0.24)	0.02 (0.16)	-	-	-	-	0.05 (0.32)	-	-	-	-	-	-	0.01 (0.10)	-	0.01 (0.10)	-	<0.01 (0.05)	-	0.14 (0.35)	-	0.02 (0.14)	35
hermit thrush	0.17 (0.38)	-	-	0.11 (0.31)	0.07 (0.26)	0.10 (0.33)	0.11 (0.37)	0.04 (0.19)	0.10 (0.32)	0.13 (0.35)	0.08 (0.28)	0.05 (0.24)	0.05 (0.22)	-	-	0.09 (0.29)	-	0.04 (0.22)	0.06 (0.24)	0.11 (0.46)	-	-	-	-	-	-	<0.01 (0.09)	-	0.04 (0.21)	0.03 (0.18)	-	0.09 (0.34)	-	0.06 (0.23)	-	-	0.06 (0.24)	0.06 (0.26)	134
house wren	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
Le Conte's sparrow	-	0.14 (0.38)	-	-	-	-	<0.01 (0.08)	-	-	-	-	-	-	-	0.17 (0.41)	-	-	-	-	-	-	-	0.26 (0.60)	0.30 (0.48)	0.20 (0.45)	-	0.08 (0.32)	-	0.13 (0.34)	0.05 (0.23)	-	0.01 (0.15)	-	<0.01 (0.08)	-	-	0.06 (0.34)	0.02 (0.16)	44
least flycatcher	0.17 (0.51)	-	-	-	-	-	<0.01 (0.08)	-	-	0.07 (0.26)	-	0.17 (0.53)	0.15 (0.49)	-	0.33 (0.82)	-	-	0.06 (0.29)	0.24 (0.56)	0.16 (0.50)	-	-	-	-	-	-	0.04 (0.24)	-	0.04 (0.21)	0.08 (0.34)	-	<0.01 (0.06)	-	0.02 (0.13)	-	-	0.06 (0.34)	0.04 (0.25)	85
Lincoln's sparrow	0.06 (0.24)	0.29 (0.76)	-	-	-	-	<0.01 (0.08)	-	-	0.07 (0.26)	-	0.01 (0.11)	-	-	0.17 (0.41)	-	-	<0.01 (0.06)	-	-	-	-	0.08 (0.27)	-	0.20 (0.45)	-	0.22 (0.52)	-	0.17 (0.49)	0.12 (0.36)	-	0.04 (0.20)	-	0.16 (0.43)	-	-	0.09 (0.29)	0.06 (0.27)	127
magnolia warbler	0.06 (0.24)	-	0.11 (0.33)	-	0.07 (0.26)	0.02 (0.12)	0.03 (0.18)	-	-	0.13 (0.35)	0.08 (0.28)	0.04 (0.20)	-	0.14 (0.38)	0.17 (0.41)	0.02 (0.15)	0.02 (0.14)	0.04 (0.22)	0.06 (0.24)	0.11 (0.32)	0.25 (0.50)	-	0.11 (0.31)	0.30 (0.67)	-	-	0.11 (0.31)	-	-	0.05 (0.23)	-	0.02 (0.13)	-	0.04 (0.20)	-	0.03 (0.16)	0.12 (0.33)	0.04 (0.21)	92
marsh wren	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20 (0.63)	0.20 (0.45)	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.05)	3
mountain bluebird	0.06 (0.24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
mourning warbler	0.06 (0.24)	-	-	-	-	-	<0.01 (0.08)	0.04 (0.19)	-	0.07 (0.26)	-	0.08 (0.30)	0.15 (0.37)	-	-	-	-	<0.01 (0.08)	0.12 (0.33)	-	-	-	-	-	-	-	<0.01 (0.09)	-	0.04 (0.21)	0.02 (0.15)	-	-	-	-	-	-	0.03 (0.17)	0.01 (0.12)	30
Nashville warbler	0.06 (0.24)	0.14 (0.38)	-	-	-	<0.01 (0.09)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.10)	-	-	-	-	-	-	-	<0.01 (0.04)	4
Nelson's sharp-tailed sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.16)	-	-	-	-	-	-	0.02 (0.15)	-	-	-	-	-	-	-	<0.01 (0.04)	3
northern waterthrush	-	-	-	-	-	-	-	-	-	0.07 (0.26)	-	-	-	-	-	-	-	<0.01 (0.06)	0.06 (0.24)	-	-	-	0.03 (0.16)	-	-	-	-	-	-	0.09 (0.32)	-	-	-	<0.01 (0.08)	-	-	0.06 (0.24)	<0.01 (0.09)	16
olive-sided flycatcher	0.11 (0.32)	-	-	-	-	<0.01 (0.09)	-	0.04 (0.19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20 (0.45)	-	0.02 (0.15)	-	-	0.02 (0.15)	-	<0.01 (0.09)	-	<0.01 (0.05)	-	-	-	<0.01 (0.08)	13
orange-crowned warbler	0.11 (0.32)	-	-	-	-	-	0.01 (0.11)	0.04 (0.19)	-	-	-	<0.01 (0.08)	-	-	-	0.02 (0.15)	-	<0.01 (0.06)	-	-	-	-	-	-	-	-	0.04 (0.28)	-	0.04 (0.21)	0.11 (0.38)	-	0.02 (0.13)	-	0.01 (0.11)	-	-	0.03 (0.17)	0.02 (0.14)	35
ovenbird	-	-	-	0.02 (0.12)	0.07 (0.26)	0.02 (0.18)	<0.01 (0.08)	0.07 (0.26)	0.10 (0.32)	0.07 (0.26)	0.46 (0.78)	0.66 (0.77)	0.30 (0.57)	0.43 (0.53)	-	0.14 (0.35)	0.40 (0.61)	0.46 (0.63)	0.18 (0.39)	0.21 (0.42)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.08)	-	0.08 (0.36)	0.03 (0.17)	0.14 (0.42)	313
palm warbler	-	0.29 (0.49)	-	0.06 (0.30)	0.07 (0.26)	0.07 (0.29)	0.13 (0.35)	-	-	-	-	-	-	-	-	0.01 (0.11)	0.04 (0.20)	<0.01 (0.08)	-	-	-	-	0.13 (0.34)	-	-	-	0.32 (0.61)	-	0.04 (0.21)	-	-	0.19 (0.50)	-	0.38 (0.64)	-	0.03 (0.16)	0.15 (0.44)	0.13 (0.41)	287
Philadelphia vireo	0.06 (0.24)	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	-	-	-	-	-	0.01 (0.10)	0.06 (0.24)	-	-	-	-	-	-	-	<0.01 (0.09)	-	-	0.04 (0.21)	-	-	-	-	-	-	0.03 (0.17)	<0.01 (0.09)	16
pine siskin	-	-	-	0.02 (0.12)	-	<0.01 (0.09)	<0.01 (0.08)	-	0.10 (0.32)	-	-	-	-	-	-	-	-	0.01 (0.23)	-	-	-	-	0.03 (0.16)	-	-	-	<0.01 (0.09)	-	-	-	-	<0.01 (0.09)	-	<0.01 (0.11)	-	-	-	<0.01 (0.11)	14
purple finch	-	-	-	0.02 (0.12)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.05)	4
red crossbill	-	-	-	-	-	-	-	-	-	-	0.08 (0.28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.10)	-	-	-	-	-	<0.01 (0.04)	4
red-breasted nuthatch	-	-	-	0.02 (0.12)	-	<0.01 (0.09)	0.02 (0.13)	0.14 (0.36)	0.20 (0.42)	-	0.08 (0.28)	0.01 (0.11)	0.15 (0.37)	-	-	0.03 (0.18)	0.06 (0.32)	0.06 (0.30)	-	0.05 (0.23)	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.12)	-	<0.01 (0.08)	-	-	0.03 (0.17)	0.02 (0.17)	48

Table F-1 Breeding Bird Average Relative Abundance (± Standard Deviation) by Land Cover Type in the Oil Sands Region, 2001 to 2011 (continued)

Habitat Group	burn		clearcut	coniferous jack pine−black spruce				coniferous white spruce			deciduous aspen−balsam poplar				linear development (vegetated)	mixedwood jack pine−aspen	mixedwood aspen−white spruce				non-linear development (vegetated)		non-treed open wetland			non-treed shrubby wetland					treed bog		treed fen			treed swamp		Overall Average or Total	Number of Birds
Map Code[(a)]	BUu	BUw	CC	a1	b4	c1	g1	d3	e3	f3	b2	d1	e1	f1	cutline	b1	b3	d2	e2	f2	clearing	wellpad	FONG	MONG	WONN	BONS	FONS	riparian	Sh	SONS	BFNN	BTNN	FFNN	FTNN	FTPN	h1	STNN		
Number of Point Counts	18	7	9	65	15	127	175	28	10	15	13	167	20	7	6	87	48	293	17	19	4	1	38	10	5	1	137	1	23	91	1	274	3	354	1	37	34	2,161	
red-eyed vireo	0.11 (0.32)	-	-	-	-	-	0.01 (0.11)	0.14 (0.36)	-	0.07 (0.26)	0.08 (0.28)	0.30 (0.54)	0.15 (0.37)	0.29 (0.49)	0.17 (0.41)	0.01 (0.11)	0.08 (0.28)	0.10 (0.31)	0.35 (0.49)	0.05 (0.23)	0.25 (0.50)	-	0.03 (0.16)	0.10 (0.32)	-	-	-	-	0.04 (0.21)	0.02 (0.15)	-	<0.01 (0.09)	-	<0.01 (0.05)	-	0.03 (0.16)	0.03 (0.17)	0.06 (0.24)	119
red-winged blackbird	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.08)	-	-	-	-	-	-	-	-	-	-	0.16 (0.44)	0.40 (0.70)	0.40 (0.89)	-	-	-	-	0.02 (0.21)	-	-	-	-	-	-	-	<0.01 (0.10)	15
rose-breasted grosbeak	-	-	-	-	-	-	-	0.04 (0.19)	-	-	-	0.04 (0.19)	-	0.14 (0.38)	-	0.01 (0.11)	0.04 (0.20)	0.03 (0.17)	0.06 (0.24)	-	-	-	-	-	0.20 (0.45)	-	-	-	-	-	-	-	-	-	-	0.03 (0.16)	-	0.01 (0.10)	23
ruby-crowned kinglet	-	-	-	0.06 (0.24)	0.20 (0.56)	0.30 (0.55)	0.31 (0.52)	0.07 (0.38)	-	0.13 (0.35)	-	0.02 (0.19)	-	-	-	0.10 (0.34)	0.10 (0.31)	0.05 (0.23)	0.06 (0.24)	-	-	-	0.03 (0.16)	0.10 (0.32)	-	-	0.09 (0.29)	-	-	0.08 (0.31)	-	0.30 (0.53)	0.67 (1.15)	0.24 (0.46)	-	0.08 (0.28)	0.26 (0.45)	0.16 (0.40)	340
rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05 (0.23)	-	-	-	0.03 (0.21)	-	-	-	-	-	-	0.01 (0.14)	-	-	-	<0.01 (0.08)	11
savannah sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.11 (0.45)	0.10 (0.32)	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	5
sedge wren	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.09)	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
song sparrow	-	-	-	-	-	-	-	-	-	-	-	-	0.05 (0.22)	-	-	-	-	-	-	0.05 (0.23)	0.25 (0.50)	-	-	-	-	-	0.01 (0.17)	-	-	-	-	<0.01 (0.09)	-	<0.01 (0.05)	-	-	-	<0.01 (0.07)	8
Swainson's thrush	-	-	0.11 (0.33)	0.03 (0.17)	0.07 (0.26)	0.07 (0.29)	0.10 (0.34)	0.14 (0.45)	0.40 (0.52)	0.20 (0.41)	0.15 (0.38)	0.06 (0.24)	0.25 (0.55)	-	-	0.07 (0.25)	0.19 (0.39)	0.14 (0.38)	0.18 (0.39)	0.26 (0.45)	0.25 (0.50)	-	0.03 (0.16)	-	-	-	0.06 (0.24)	-	0.04 (0.21)	0.19 (0.56)	-	0.05 (0.21)	-	0.07 (0.28)	-	0.22 (0.42)	0.24 (0.43)	0.09 (0.32)	205
swamp sparrow	-	-	-	-	0.07 (0.26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.29 (0.61)	-	-	-	0.11 (0.43)	1 (na)	0.04 (0.21)	0.34 (0.54)	-	<0.01 (0.06)	-	0.03 (0.18)	-	-	0.09 (0.29)	0.03 (0.21)	74
Tennessee warbler	0.39 (0.61)	0.29 (0.49)	0.89 (1.05)	0.32 (0.66)	0.67 (0.72)	0.13 (0.42)	0.26 (0.58)	1.21 (1.03)	1.50 (0.85)	1.27 (1.10)	0.62 (0.77)	0.63 (0.85)	1.05 (1.23)	1 (0.82)	0.17 (0.41)	0.40 (0.74)	0.65 (0.84)	0.77 (0.89)	1.12 (1.17)	0.58 (0.69)	0.25 (0.50)	-	0.16 (0.44)	0.50 (0.97)	0.60 (0.89)	-	0.32 (0.64)	-	0.39 (0.66)	0.75 (0.93)	-	0.39 (0.77)	0.67 (0.58)	0.27 (0.62)	-	0.54 (0.80)	0.82 (1.19)	0.48 (0.79)	1,033
tree swallow	0.11 (0.47)	-	-	-	-	<0.01 (0.09)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05 (0.32)	-	0.40 (0.89)	-	0.03 (0.24)	-	-	-	-	-	-	<0.01 (0.08)	-	-	-	<0.01 (0.10)	13
varied thrush	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
vesper sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.09)	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	<0.01 (0.03)	2
warbling vireo	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.08)	-	-	0.17 (0.41)	-	-	-	0.06 (0.24)	0.05 (0.23)	-	-	-	-	-	-	-	-	-	0.01 (0.10)	-	-	-	-	-	-	-	<0.01 (0.05)	5
western tanager	-	-	-	0.02 (0.12)	-	-	-	0.07 (0.26)	0.10 (0.32)	0.07 (0.26)	0.23 (0.60)	0.02 (0.15)	0.05 (0.22)	-	-	0.01 (0.11)	0.13 (0.39)	0.09 (0.31)	0.06 (0.24)	0.05 (0.23)	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	0.03 (0.17)	0.02 (0.16)	49
western wood-pewee	-	-	-	-	-	-	-	0.04 (0.19)	-	-	-	-	-	-	-	-	-	<0.01 (0.08)	-	-	-	-	0.03 (0.16)	0.10 (0.32)	0.20 (0.45)	-	<0.01 (0.09)	-	-	0.01 (0.10)	-	-	-	0.02 (0.16)	-	-	-	<0.01 (0.09)	15
white-breasted nuthatch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.16)	-	<0.01 (0.02)	1
white-crowned sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	<0.01 (0.02)	1
white-throated sparrow	0.11 (0.32)	0.29 (0.49)	0.22 (0.67)	0.02 (0.12)	0.13 (0.35)	0.02 (0.12)	0.02 (0.13)	-	-	0.20 (0.41)	0.08 (0.28)	0.13 (0.38)	0.30 (0.66)	-	-	-	-	0.05 (0.28)	0.18 (0.39)	0.16 (0.37)	0.25 (0.50)	-	0.03 (0.16)	0.10 (0.32)	-	-	0.15 (0.43)	-	0.17 (0.49)	0.27 (0.56)	-	0.05 (0.30)	-	0.09 (0.33)	-	0.05 (0.23)	0.44 (0.86)	0.09 (0.33)	184
white-winged crossbill	-	-	-	0.02 (0.12)	-	-	0.01 (0.11)	-	0.10 (0.32)	0.07 (0.26)	-	0.01 (0.11)	0.15 (0.49)	-	-	0.05 (0.30)	-	0.02 (0.15)	0.06 (0.24)	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.26)	-	0.04 (0.42)	-	0.03 (0.16)	-	0.02 (0.23)	43
Wilson's warbler	0.06 (0.24)	-	-	-	-	<0.01 (0.09)	<0.01 (0.08)	0.04 (0.19)	-	-	-	-	-	0.14 (0.38)	-	0.01 (0.11)	-	-	-	0.05 (0.23)	-	-	0.05 (0.32)	-	-	-	0.05 (0.22)	-	0.04 (0.21)	0.19 (0.45)	-	0.01 (0.15)	-	0.02 (0.13)	-	-	0.03 (0.17)	0.02 (0.16)	45
winter wren	-	-	-	-	-	<0.01 (0.09)	<0.01 (0.08)	0.07 (0.26)	0.20 (0.42)	0.13 (0.35)	-	0.02 (0.13)	0.05 (0.22)	-	-	0.01 (0.11)	0.02 (0.14)	0.04 (0.20)	0.12 (0.33)	0.11 (0.32)	-	-	-	-	-	-	<0.01 (0.09)	-	0.04 (0.21)	0.05 (0.23)	-	<0.01 (0.09)	-	<0.01 (0.08)	-	0.08 (0.28)	0.09 (0.29)	0.02 (0.15)	47
yellow warbler	-	-	-	0.03 (0.17)	0.07 (0.26)	0.02 (0.18)	0.01 (0.11)	-	-	0.07 (0.26)	-	<0.01 (0.08)	-	-	-	-	0.04 (0.20)	<0.01 (0.08)	0.06 (0.24)	0.11 (0.32)	-	-	-	-	-	-	0.03 (0.17)	-	-	0.04 (0.25)	-	<0.01 (0.09)	-	<0.01 (0.05)	-	-	0.06 (0.24)	0.01 (0.12)	29
yellow-bellied flycatcher	-	-	-	0.02 (0.12)	-	-	0.03 (0.17)	-	-	-	-	-	-	-	-	0.01 (0.11)	-	<0.01 (0.06)	-	-	-	-	0.03 (0.16)	-	-	-	0.01 (0.12)	-	-	0.01 (0.10)	-	0.02 (0.16)	-	0.03 (0.20)	-	-	-	0.01 (0.12)	29

Table F-1 Breeding Bird Average Relative Abundance (± Standard Deviation) by Land Cover Type in the Oil Sands Region, 2001 to 2011 (continued)

Habitat Group	burn		clearcut	coniferous jack pine−black spruce				coniferous white spruce			deciduous aspen−balsam poplar				linear development (vegetated)	mixedwood jack pine−aspen	mixedwood aspen−white spruce				non-linear development (vegetated)		non-treed open wetland			non-treed shrubby wetland					treed bog		treed fen			treed swamp		Overall Average or Total	Number of Birds
Map Code[(a)]	BUu	BUw	CC	a1	b4	c1	g1	d3	e3	f3	b2	d1	e1	f1	cutline	b1	b3	d2	e2	f2	clearing	wellpad	FONG	MONG	WONN	BONS	FONS	riparian	Sh	SONS	BFNN	BTNN	FFNN	FTNN	FTPN	h1	STNN		
Number of Point Counts	18	7	9	65	15	127	175	28	10	15	13	167	20	7	6	87	48	293	17	19	4	1	38	10	5	1	137	1	23	91	1	274	3	354	1	37	34	2,161	
yellow-bellied sapsucker	-	-	-	0.02 (0.12)	0.07 (0.26)	-	0.01 (0.11)	-	0.20 (0.42)	-	0.46 (0.66)	0.10 (0.31)	0.05 (0.22)	-	-	-	-	0.05 (0.23)	0.12 (0.33)	0.05 (0.23)	-	-	-	-	-	-	<0.01 (0.09)	-	-	0.03 (0.18)	-	-	-	<0.01 (0.05)	-	-	-	0.02 (0.16)	51
yellow-headed blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.06)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01 (0.02)	1
yellow-rumped warbler	-	-	0.33 (0.71)	0.35 (0.54)	0.47 (0.83)	0.60 (0.77)	0.45 (0.59)	0.18 (0.48)	-	0.13 (0.35)	0.08 (0.28)	0.12 (0.33)	0.25 (0.55)	-	0.17 (0.41)	0.36 (0.61)	0.15 (0.36)	0.25 (0.49)	0.18 (0.39)	0.16 (0.37)	-	-	0.05 (0.23)	0.10 (0.32)	-	-	0.19 (0.39)	-	-	0.09 (0.32)	1 (na)	0.36 (0.58)	-	0.36 (0.55)	-	0.30 (0.52)	0.26 (0.45)	0.29 (0.53)	625
Overall Average or Total	3.22 (2.29)	3.0 (3.56)	2.56 (2.40)	1.69 (1.54)	2.67 (1.72)	1.94 (1.53)	2.13 (1.53)	3.61 (2.06)	4.60 (2.01)	4.73 (2.58)	3.15 (1.68)	3.16 (2.03)	4.45 (1.93)	2.86 (1.07)	1.83 (2.14)	1.90 (1.42)	2.81 (1.45)	3.08 (2.20)	4.35 (2.12)	3.47 (2.44)	4.0 (1.41)	2 (na)	2.55 (2.44)	2.90 (1.52)	2.80 (1.92)	1 (na)	3.04 (2.17)	3 (na)	2.96 (2.25)	4.78 (2.97)	2 (na)	2.51 (1.98)	2 (2.00)	2.74 (1.85)	1 (na)	2.76 (1.72)	4.41 (2.82)	2.83 (2.10)	6,122

(a) See Table F-2 for land cover type associated with each map code.

Note: Breeding bird species values are the average number of individual birds observed per point count (plus or minus standard deviation). Where standard deviation is (na), there was only one point count; average and standard deviation could not be calculated.

Table F-2 Breeding Bird Average Relative Abundance, Species Richness and Diversity (± Standard Deviation) in Land Cover Types in the Oil Sands Region, 2001 to 2011

Habitat Group	Map Code	Land Cover Type[a]	Number of Point Counts	Number of Birds	Average Relative Abundance	Average Species Richness	Average Species Diversity[b]
burn	BUu	burned upland	18	58	3.22 (2.29)	2.78 (1.73)	0.84 (0.64)
	BUw	burned wetland	7	21	3.0 (3.56)	2.57 (2.44)	0.68 (0.67)
clearcut	CC	disturbed - clearcut	9	23	2.56 (2.40)	1.78 (1.48)	0.60 (0.50)
coniferous jack pine−black spruce	a1	lichen jack pine	65	110	1.69 (1.54)	1.49 (1.30)	0.43 (0.50)
	b4	blueberry white spruce-jack pine	15	40	2.67 (1.72)	2.33 (1.68)	0.70 (0.57)
	c1	Labrador tea–mesic jack pine-black spruce	127	246	1.94 (1.53)	1.61 (1.18)	0.43 (0.50)
	g1	Labrador tea–subhygric black spruce-jack pine	175	373	2.13 (1.53)	1.90 (1.28)	0.55 (0.52)
coniferous white spruce	d3	low-bush cranberry white spruce	28	101	3.61 (2.06)	2.86 (1.94)	0.83 (0.64)
	e3	dogwood white spruce	10	46	4.60 (2.01)	3.90 (1.66)	1.22 (0.52)
	f3	horsetail white spruce	15	71	4.73 (2.58)	3.93 (1.91)	1.20 (0.52)
deciduous aspen−balsam poplar	b2	blueberry aspen-white birch	13	41	3.15 (1.68)	2.69 (1.44)	0.87 (0.56)
	d1	low-bush cranberry aspen	167	527	3.16 (2.03)	2.58 (1.48)	0.80 (0.53)
	e1	dogwood balsam poplar-aspen	20	89	4.45 (1.93)	3.50 (2.04)	1.03 (0.65)
	f1	horsetail balsam poplar-aspen	7	20	2.86 (1.07)	2.57 (1.13)	0.82 (0.57)
linear development (vegetated)	cutline	disturbed - cutline	6	11	1.83 (2.14)	1.67 (1.75)	0.38 (0.64)
mixedwood aspen−white spruce	b3	blueberry aspen-white spruce	48	135	2.81 (1.45)	2.42 (1.37)	0.78 (0.51)
	d2	low-bush cranberry aspen-white spruce	293	903	3.08 (2.20)	2.57 (1.74)	0.78 (0.59)
	e2	dogwood balsam poplar-white spruce	17	74	4.35 (2.12)	3.71 (1.72)	1.16 (0.49)
	f2	horsetail balsam poplar-white spruce	19	66	3.47 (2.44)	3.21 (2.27)	0.92 (0.75)
mixed wood jack pine−aspen	b1	blueberry jackpine-aspen	87	165	1.90 (1.42)	1.62 (1.10)	0.44 (0.47)
non-linear development (vegetated)	clearing	disturbed - clearing	4	16	4.0 (1.41)	3.25 (2.06)	0.98 (0.78)
	wellpad	disturbed - wellpad	1	2	2 (na)	1 (na)	0 (na)

Table F-2 Breeding Bird Average Relative Abundance, Species Richness and Diversity (± Standard Deviation) in Land Cover Types in the Oil Sands Region, 2001 to 2011 (continued)

Habitat Group	Map Code	Land Cover Type[(a)]	Number of Point Counts	Number of Birds	Average Relative Abundance	Average Species Richness	Average Species Diversity[(b)]
non-treed open wetland	FONG	graminoid fen	38	97	2.55 (2.44)	2.05 (1.93)	0.60 (0.63)
	MONG	graminoid marsh	10	29	2.90 (1.52)	2.30 (0.95)	0.72 (0.44)
	WONN	open water	5	14	2.80 (1.92)	2.20 (1.48)	0.75 (0.52)
non-treed shrubby wetland	BONS	shrubby bog	1	1	1 (na)	1 (na)	0 (na)
	FONS	shrubby fen	137	417	3.04 (2.17)	2.58 (1.72)	0.77 (0.60)
	riparian	riparian	1	3	3 (na)	3 (na)	1.10 (na)
	Sh	shrubland	23	68	2.96 (2.25)	2.52 (1.90)	0.74 (0.62)
	SONS	shrubby swamp	91	435	4.78 (2.97)	3.88 (2.17)	1.17 (0.61)
treed bog	BFNN	forested bog	1	2	2 (na)	2 (na)	0.69 (na)
	BTNN	wooded bog	274	689	2.51 (1.98)	2.05 (1.47)	0.60 (0.55)
treed fen	FFNN	forested fen	3	6	2.00 (2.00)	1.67 (1.53)	0.58 (0.53)
	FTNN	wooded fen	354	970	2.74 (1.85)	2.35 (1.50)	0.70 (0.57)
	FTPN	wooded fen with patterning	1	1	1 (na)	1 (na)	0 (na)
treed swamp	h1	Labrador tea/horesetail white spruce-black spruce	37	102	2.76 (1.72)	2.35 (1.38)	0.74 (0.53)
	STNN	wooded swamp	34	150	4.41 (2.82)	3.62 (2.16)	1.07 (0.63)
Overall Average or Total			**2,161**	**6,122**	**2.83 (2.10)**	**2.38 (1.66)**	**0.71 (0.59)**

(a) Based on ecosite phase classification of Beckingham and Archibald (1996) and wetlands type classification of Halsey et al. (2003).

(b) Species diversity was calculated for each point count using the Shannon diversity index (see methods for more details).

Note: Bird values are the average number of individual birds, species, or diversity values observed per point count (plus or minus standard deviation). Where standard deviation is (na), there was only one point count; average and standard deviation could not be calculated.

1 REFERENCES

Beckingham, J.D. and J.H. Archibald. 1996. *Field Guide to Ecosites of Northern Alberta*. Natural Resources Canada. Canadian Forest Service, Northwest Region, Northern Forestry Centre. Special Report 5. Edmonton, AB.

Halsey, L.A., D.H. Vitt, D. Beilman, S. Crow, S. Mehelcic and R. Wells. 2003. *Alberta Wetlands Inventory Standards, Version 2.0*. Alberta Sustainable Resource Development, Resource Data Branch. Edmonton, AB. 54 pp. ISBN: 0778523233.